The Welding Engineer

Edited by L. B. Mackenzie

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ANYTHING and EVERYTHING for OXYACETYLENE WELDING and CUTTING

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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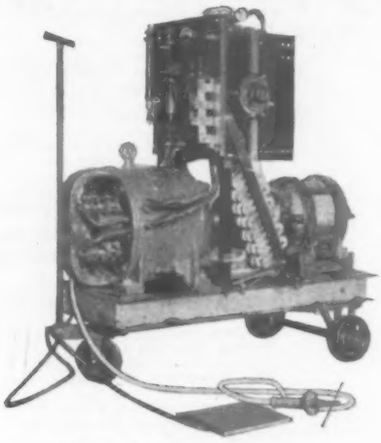

Single Arc Portable Unit

Two-Arc Gasoline Engine Driven Unit

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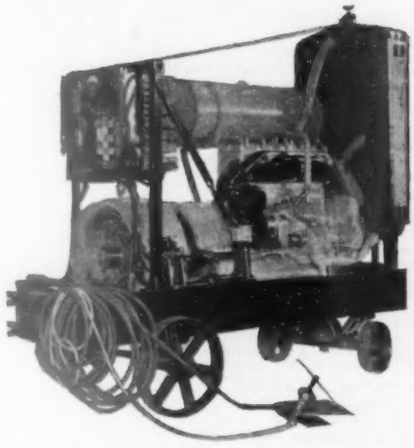
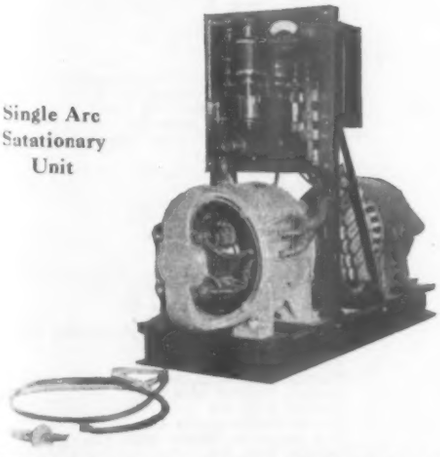


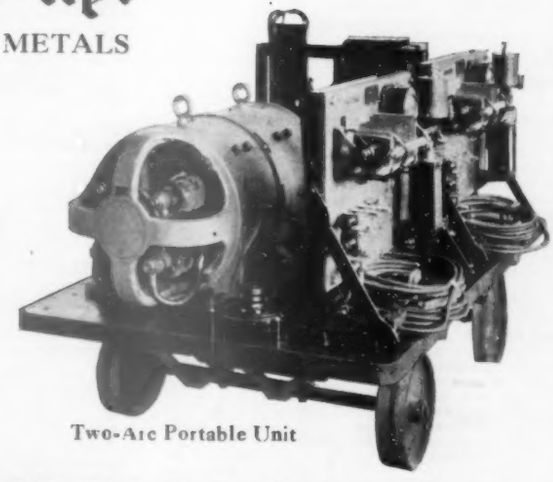
Single Arc Gasoline Engine Driven Unit

Single Arc Belt Unit

WILSON
"Color-tipt"
WELDING METALS



Single Arc Satationary Unit



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Bierman-Everett Fdy. Co.
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Davis-Bournonville Co.
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Modern Engineering Co.
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Purox Co.
Page Steel & Wire Co.
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United States Welding Co.

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Wm. Cramp & Sons
Davis-Bournonville Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Purox Co.
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Reid-Avery Co.
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Modern Engineering Co.
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Superior Oxy-Acetylene Machine Co.
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Davis-Bournonville Co.
Harris Calorific Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
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International Oxygen Co.
The Imperial Brass Mfg. Co.
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Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
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International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Metals Welding Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Purox Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
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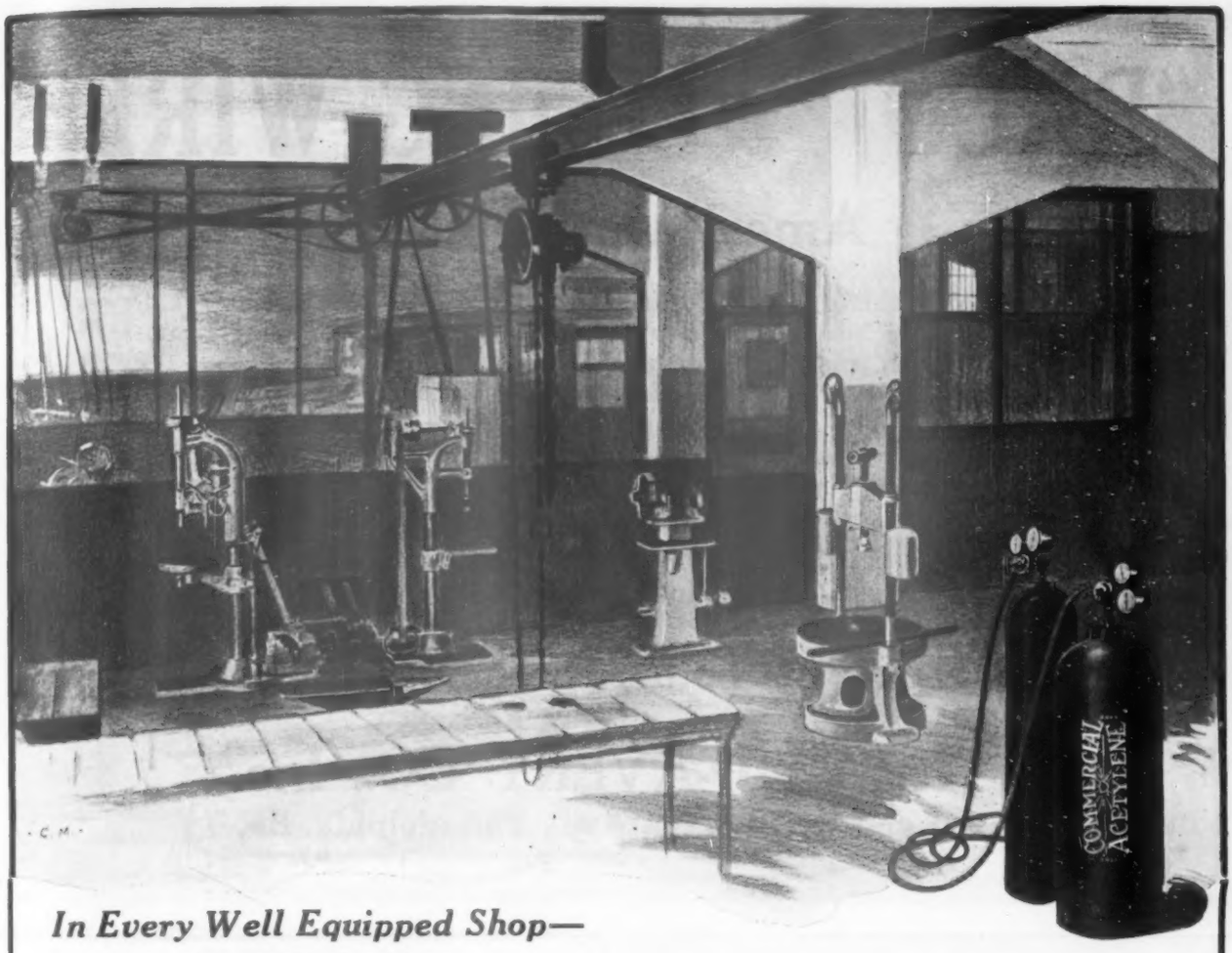

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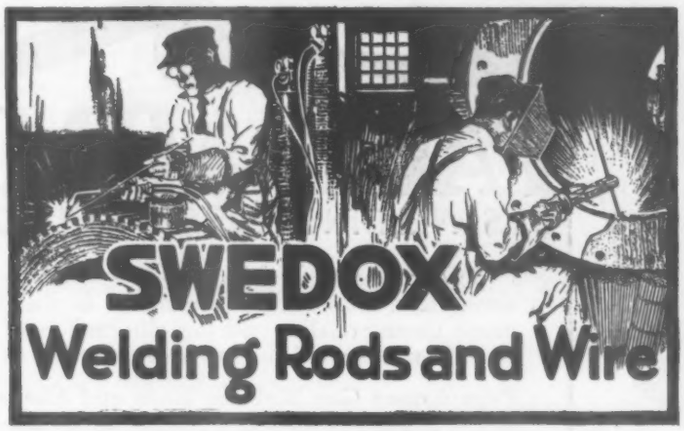

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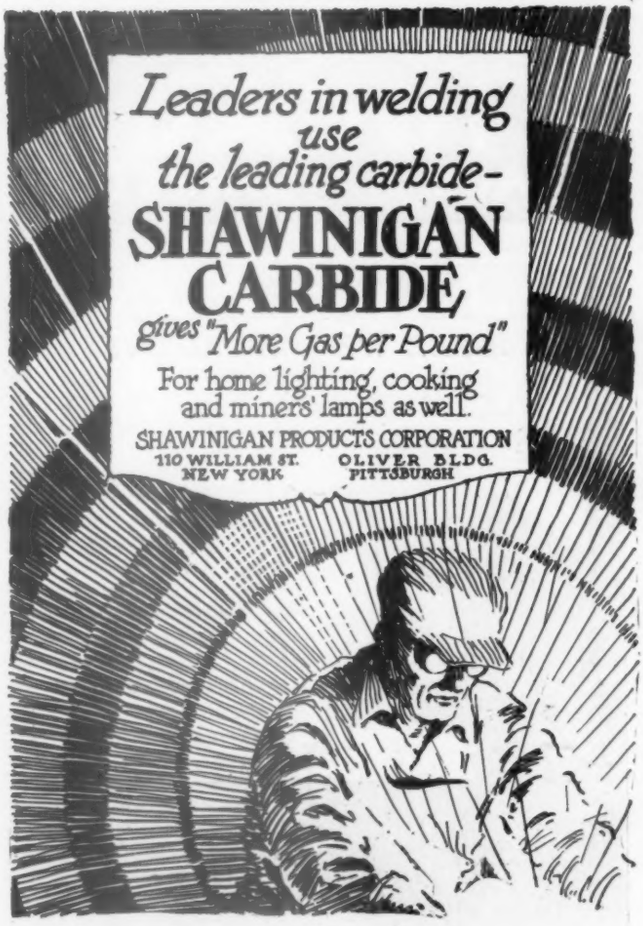

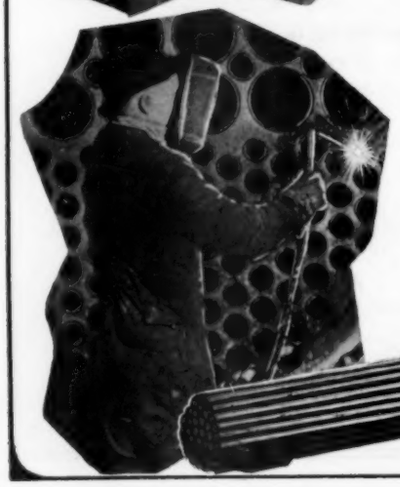

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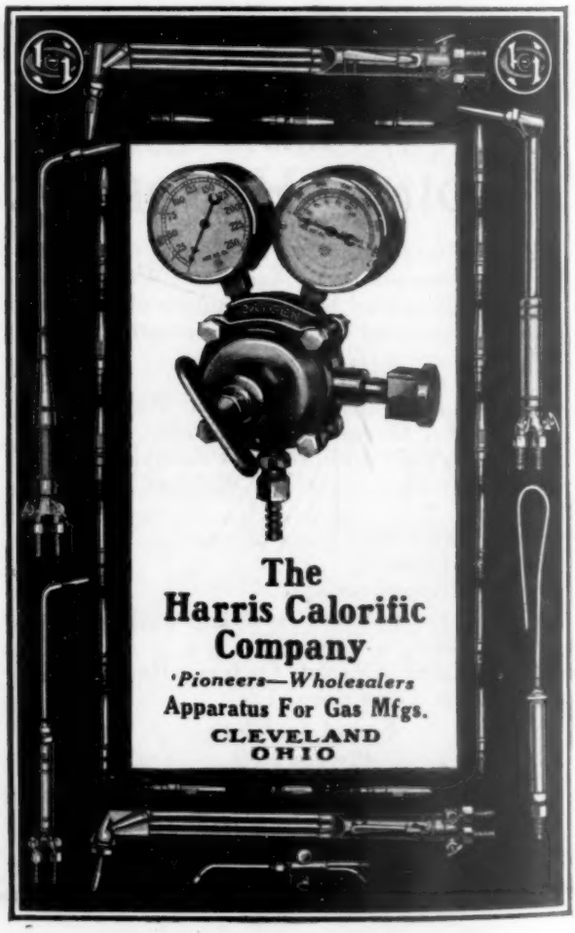

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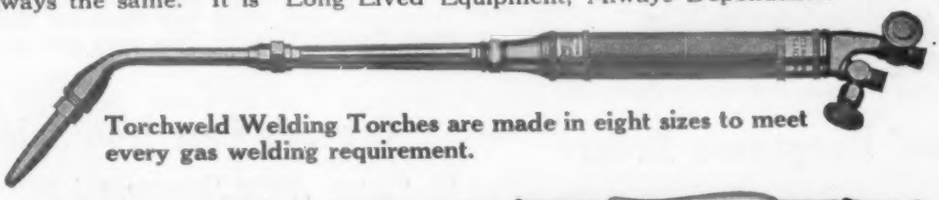

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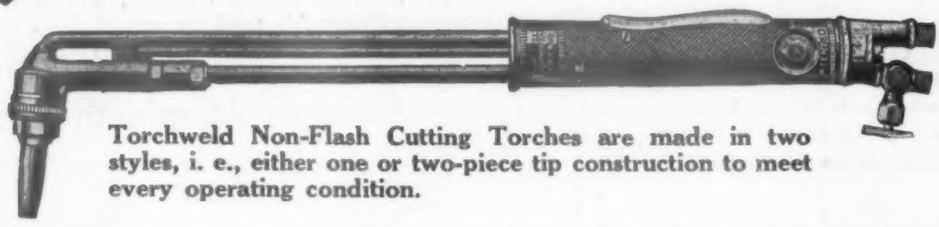

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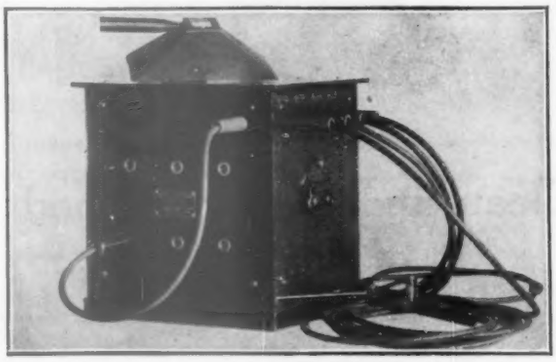

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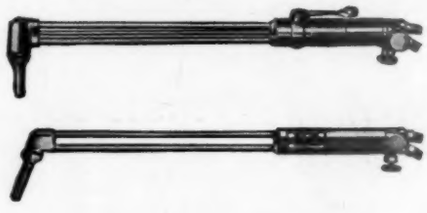

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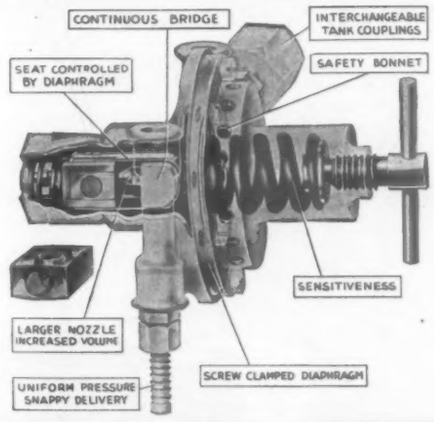

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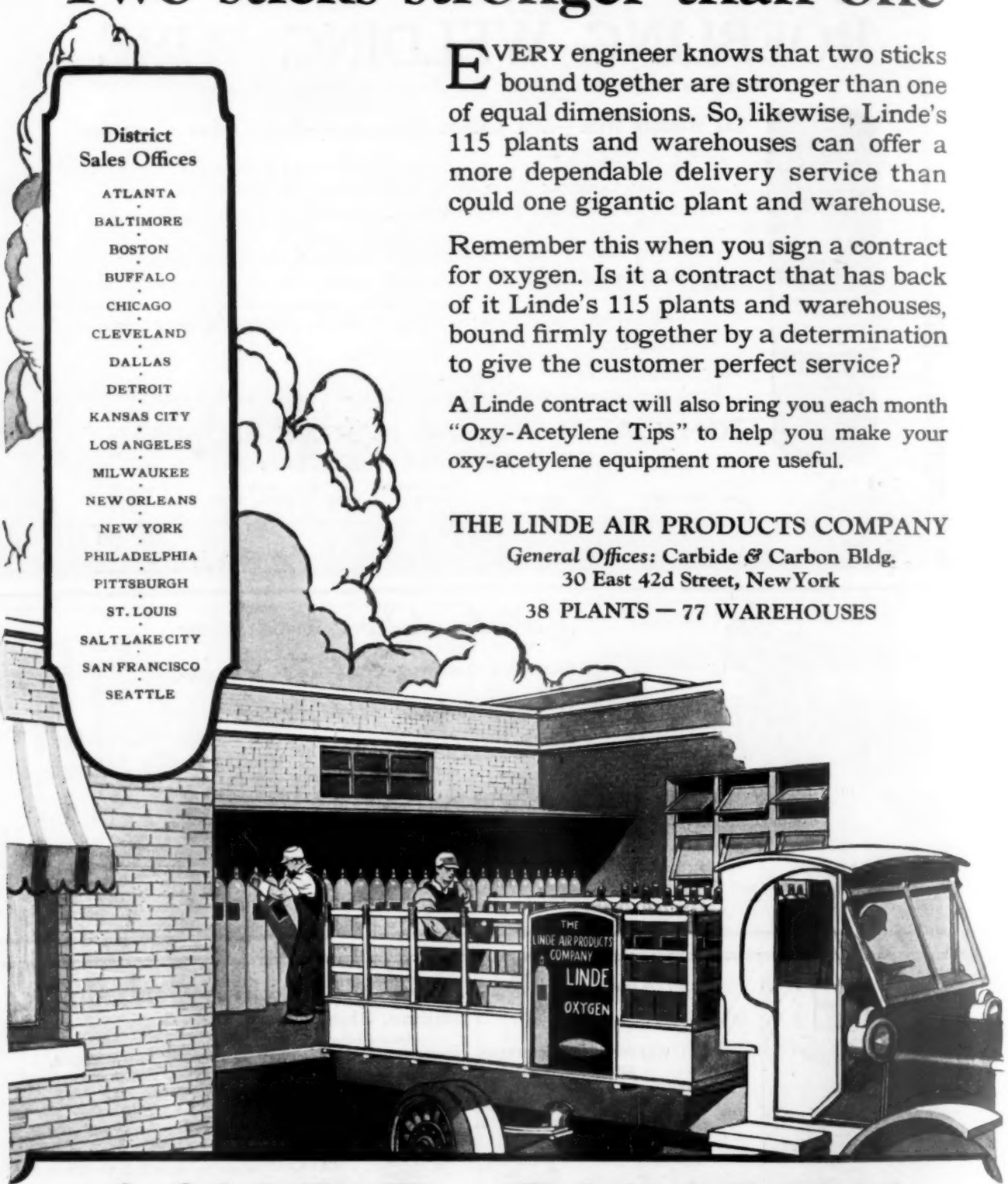

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PROPERTIES OF STEEL IN WELDING†

Effect of Heat Treatment on Ductility and Toughness—Tensil Properties of Deposited Metals—Effect of Different Elements

By Prof. F. C. Thompson, D., Met., B. Sc.

THE making of welded joints is of such importance and so far reaching in its effects, that it is essential that extensive studies of the properties of welded material should be effected. As bearing on this, if there is one point in connection with the testing of engineering material which has been proved beyond doubt, it is that determinations of tensile strength alone are almost worthless. Instances in scores may be cited in which materials with identical tensile strengths have shown enormously different properties in other directions. There is no factor revealed by the tensile test which is so little effected by modifications of treatment as the maximum stress. Yet how rare is it to find any other value given in work on the strength of welds. The difficulties of determining say the elastic limit, impact value or even elongation are sufficiently obvious, but it is only in so far as information of this type is available that the engineer can be expected to place reliance in welded joints and to use them in cases other than under compulsion.

That a welded joint is in most cases seriously overheated there can be no doubt. This overheating results both in excessive grain growth, and in an acutely angular and brittle structure. With regard to the former the following figures will illustrate the effect of grain growth in practically pure iron:

No. of Grains per linear inch.	True Elastic Limit, Tons per sq. in.	Maximum Stress, Tons per sq. in.
70	4.0	21
170	5.0	22
360	12	22.5

It will be observed that, although the tensile strength is, to all intents and purposes, unaffected by the change in grain size, the elastic limit, really a far more important factor, is profoundly altered. In connection with welds made with almost pure iron such figures are of the utmost importance.

The effect of grain size in steel is of at least equal importance, as the following figures which refer to a 0.5%C. steel show:

No. of Grains per linear inch.	Maximum Stress, Tons per sq. in.	Reduction of Area per cent.
210	44	20
222	44.5	22
322	47	35

Again, the extremely small effect on the tensile strength will be apparent.

It is true that if all that is required is to determine whether or not the weld is half slag, the tensile strength will answer the question, but so would also other simpler tests, such as the bending test.

It is not going too far to ask whether some form of heat treatment such as that adopted in the refining of an overheated steel might not be applied in at any rate a certain number of welds. If the weld is mechanically defective it is clear that no treatment can be expected to put this right, but assuming that the weld has been properly made, it is still in an overheated condition, and this would be remedied by the treatment. The effect of normalizing on the structure of a badly overheated steel is shown in Figs. 1 and 2. All that is required is that the steel should be taken up to the temperature of the Ac.3 point and cooled in air. The temperature corresponding to this change for a few different carbon steels is shown in Table I below.

TABLE I

Carbon per cent.	Temperature °C.
0.1	900
0.2	865
0.3	825
0.4	790
0.6	770

The effect of such a refining treatment on the ductility and toughness is very marked. In cases of welds which may subsequently be stressed at all heavily, such a procedure wherever it may be adopted has much to recommend it.

Figure 1. Overheated Steel X 75

In this connection it may be pointed out that at times such a process is to some extent automatically effected. As the successive layers of metal are deposited the heat tends to refine the structure of that material already laid down. As a result the last material fused possesses the overheated structure in a very obvious manner, while the earlier metal has a structure which is more normal. Any modification of practice which can be adopted to increase this refining of the earlier layers will tend to improve the properties of the final weld.

With regard to the mechanical soundness of a weld, attention may be drawn to a method which has been adopted in America for somewhat similar investigations. The principle of the method is that if an identical cyclical magnetic flux passes through two specimens of identical material so that the direction in one is reversed in the other it will exert no effect on a galvanometer. If, however, the two samples are not the same, one being sound and the other say defective, then the needle will be deflected. This method has actually been used in America to detect flaws in rails and rifle barrels. It has been suggested that it might be used to detect failure of the internal strands in colliery ropes and is in use on an experimental scale in this country to detect unsound wire at an early stage in the manufacture.

A research of real interest on arc welding was carried out by the Bureau of Standards, in America.* Among the questions investigated was that of the real tensile properties of the deposited

†*Paper read before members of the Institution of Welding Engineers, March* 17, 1924.

Bureau of Standards, Tech. Paper, 179.

metal, and the average of some 54 tests is shown below. The metal was built up into masses sufficiently big for the actual preparation of a standard test-piece.

Limit of Proportionality, tons per sq. in	11
Yield Point, tons per sq. in	15
Maximum Stress, tons per sq. in	21
Elongation per cent on 2 ins	8.5
Reduction of Area, per cent	11
Brinnell Hardness	103
Scleroscope Hardness	16

These figures are taken from test-pieces which have been prepared with the successively deposited portions orientated longitudinally. When, however, the test-piece is cut with the "fibre" lying transverse to the direction of the stress, a condition of affairs

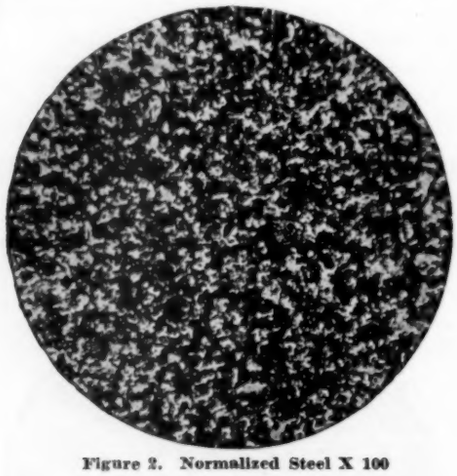

Figure 2. Normalized Steel X 100

which will often be met with in practice, the results are less satisfactory. The mean of the tests recorded are:

Yield Point, tons per sq. in	10
Maximum Stress, tons per sq. in	18
Elongation, per cent on 2 ins	5
Reduction of Area, per cent	6

It is only in the light of such figures as these that a just appreciation of the properties of even a good weld can be attained. These figures could be appreciably improved by heat-treatment.

The Bureau of Standards' results are also of interest in that they show that there is no appreciable difference, either in composition or in properties, of metal deposited from coated and uncoated electrodes. Further, the variation of the current between 110 and 300 amperes produced no alteration of importance on the properties of the deposited material.

With regard to the composition of steels for welding, it is not easy to dogmatize. For instance, it is well known in other metals than iron that the presence of gases exerts a very marked influence on the weld ability of the material. As an illustration, this fact is put to use by the dentist in the gold filling of teeth. Two types of gold are used for this purpose. The first is what is called "cohesive" gold, and is very pure. Under the pressure applied in packing, the material will weld even at the temperature of the mouth. The other type, or the "non-cohesive" gold, is so treated that it will not weld. The essential feature of the latter appears to lie in the fact that it contains abundant amounts of gas, nitrogen and hydrogen, derived from the decomposition of ammonia at high temperatures. These gases entirely prevent the metal from welding under conditions such that the gas-free gold would weld readily.

This is a very simple example of the effect of gases in so far as they affect the weldability of a metal, and he would be a brave man who denied a similar effect in iron or steel. At the same time nothing of a really definite nature is known. There is the feeling among experienced men that two samples of steel of the same ordinary analysis will not weld equally readily, and since there are many aspects of the chemical composition of a steel which are not revealed by the ordinary "complete" analysis, this may well be true. At the same time there are many instances in which the treatment and not the material is at fault. As an illustration of this fact, a case which came to the author's attention recently, may be of interest:

Steel wires of essentially identical composition were obtained from two different makers. While one sample was said to weld well, the other was stated to be bad. The analysis revealed no explanation for this, and gases and other recondite factors were drawn in to explain the difference. A microscopic examination, however, at once provided an explanation. The structures of the good and bad welds are shown in Figs. 3 and 4. It will be seen that while the good steel had given a typical good weld, the bad one had been seriously carburized in the treatment, with the result that the endeavor was being made to weld one piece of fairly high carbon steel to another. Clearly the welding operation, and not the steel itself, was the cause of the trouble.

It would appear from general principles that that steel would weld most readily in which the crystals, given a fair chance, would grow the quickest. In this connection the results of some work done recently on the grain growth in iron and steels of different carbon and manganese contents is of interest.

The steels were heated for 1 hour to 800° C., a temperature which, although far below what is often attained in welding, will still bring out the different rates of grain growth. In the first series only the carbon content showed any appreciable alteration, while in the second this was constant at about 0.4 per cent and the manganese varied. After the treatment the number of grains per square millimeter was very carefully counted.

(A) Carbon Series

Carbon per cent.	Number of Grains.
0.04	272
0.37	802
0.58	1,200

(B) Manganese Series

Manganese per cent.	Number of Grains
0.05	802
0.54	1,330
0.89	3,518

In each case it will be noted that the rate of grain growth becomes smaller and the crystals finer as both the carbon and the

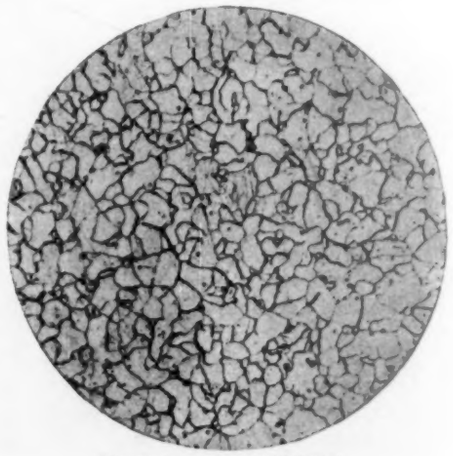

Figure 3. Good Weld X 75

manganese rise. It would appear to be probable, therefore, that welding becomes progressively difficult as the content of either element is raised. It is known that this is the case with carbon, and the feeling that manganese also hinders welding would appear to find some justification.

It has been shown, however, many times, that during electric

welding the oxidation which takes place reduces not only the carbon in the electrode material but also other elements, such as silicon, and in particular from the present point of view, the manganese. The following analyses are taken from data contained in Judge's "Aircraft and Automobile Materials."

	C. per cent.	Si. per cent.	Mang. per cent.	S. per cent.	P. per cent.
Electrode	0.14	0.11	0.35	0.03	0.015
Metal deposited in weld	0.03	0.02	0.04	0.03	0.020

It will be clear that more or less acrimonious discussions as to the acceptability of steel containing slight variations of carbon,

Figure 4. Bad Weld X 75

silicon, or manganese for electrode material, are totally unnecessary. Over wide ranges of composition of electrodes, the composition of the weld material itself is the same.

This reduction of manganese is of fundamental importance from another point of view. It is known that in an ordinary steel the sulphur is present as manganese sulphide, while in an absolutely pure iron-carbon alloy any sulphur present would occur as iron sulphide. The effect of sulphur is almost invariably detrimental to the steel, but this is specially the case where it is present as ferrous sulphide. Arnold has demonstrated this exceedingly clearly. An iron alloy without manganese containing about 1 per cent of sulphur, as iron sulphide, of course, when tested in tension gave the following result:

Yield Point, tons per sq. in	2.5
Maximum Stress, tons per sq. in	2.5
Elongation per cent	0
Reduction of Area	0
Bend Angle	0

The sulphur in this form is highly dangerous there can thus be no doubt. This, of course, was a freak material, but iron sulphide even in very small amounts exerts a most pernicious effect.

In the presence of manganese the effect, though still bad, is far less serious as the following tensile tests show. The compositions of the steels used were:

Carbon, per cent.	Manganese, per cent.	Sulphur, per cent.
0.46	1.07	0.55
0.47	1.04	0.02

The tensile tests of the two materials were those shown in Table II.

TABLE II

	Low Sulphur.	High Sulphur.
Yield Point, tons per sq. in	41	21
Maximum Stress, tons per sq. in	52	39
Elongation per cent	25	17
Reduction of Area, per cent	50	24

Now although the ill effect of the sulphur is clear, it is equally clear that the one per cent of manganese present has rendered it far less harmful than it would have been in the absence of that element.

Now the point to which attention must be drawn is, that, since the material actually deposited in the weld is almost manganese free, the effect of sulphur will be at its worst. The sulphur present will be as iron sulphide, and its embrittling influence will be appreciable. The sulphur present in the electrode is not reduced by fusion, and if anything tends to increase, and the advisability of using low sulphur material becomes apparent. At the best the sulphide acts as slag and breaks up the metallic continuity of the weld.

In gas welding the sulphur question again arises, though from a rather different point of view. Molten iron or even solid iron at high temperatures absorbs sulphur from sulphurous gases with extreme avidity. It is, therefore, in the highest degree essential that the gases which come in contact with the hot metal should be as nearly sulphur free as possible.

A similar absorption of phosphorus from gases containing compounds of this element occurs, and their removal is as necessary as is that of sulphur.

The effect of phosphorus on a medium carbon has been examined by Stead. The effect of this element becomes greater as the carbon content of the material is increased, and concerning its evil influence there can be no doubt. High phosphorus steel is "wicked," prone to result in sudden failure and liable to excessive grain growth. There is little if any evidence that this element affects the facility with which the weld may be made but it appears equally certain that the properties of the finished weld will suffer appreciably if the phosphorus content is high.

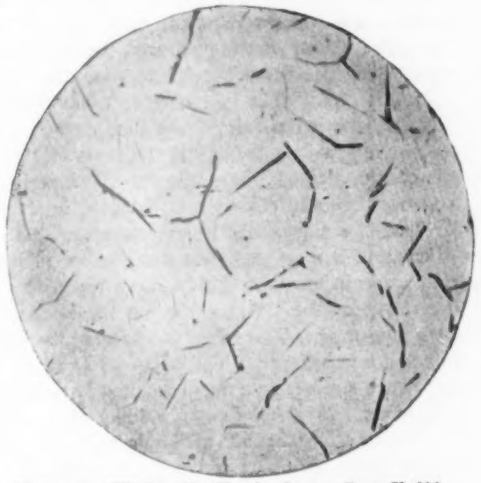

Figure 5. Nitride Needles in Armco Iron X 600

	Phosphorus, per cent. 0.04	0.30	0.50
Yield Point, tons per sq. in	20.4	25.4	32.0
Maximum Stress, tons per sq. in	33.1	39.9	44.2
Elongation per cent on 2 ins	23	23	20
Reduction of Area, per cent	52	45	45
Wöhler Test (thousands of revs.)	61.1	167.7	651.5
Arnold Test	271	200	100
Slow Bend	605	446	150
Impact Test, ft. lbs	58	7	1

It will be seen that the high phosphorus material has a much higher tensils strength with a very fair ductility, but in face of the impact tests no sane person would ever allow such a steel to pass into service. The two latter cases are abnormal but they

illustrate well what may be expected where phosphorus absorption of a weld is great.

A point not without importance with the composition of the weld material is the question of the nitrogen which is absorbed during the fusion.

Starting with a steel containing a trace only of that element, the nitrogen content of the weld has been shown by the Bureau of Standards to average about 0.12 per cent, a high important quantity. The nitrogen thus introduced forms a chemical compound with the iron, and this is seen in the microstructive as long, thin plates or needles (Fig. 5.) This material is exceedingly brittle and very hard, and it will thus act as a series of stiffening barriers when the metal tries to flow under stress. The result then is that the metal is rendered less ductile and prone to fracture under low loads with very little elongation and under shock to fail with serious readiness.

The nitrogenisation would appear to be due either to the formation of ammonia, with the moisture present in the air, etc., under the influence of the arc, which gas is known to nitrogenise iron with the formation of Fe_3N_2, or to the formation of some specially active form of nitrogen which reacts directly with the metal. The amount of nitrogen absorbed by the metal increases slightly as the current employed is raised.

Another aspect of welding which is of importance though it has never apparently received very adequate attention is that of the internal stresses which are set up. There can be no doubt that a fusion weld is stressed at times somewhat severely. Annealing, especially of the type mentioned early in this Paper, causes the entire dissipation of such stresses and can have therefore nothing but beneficial results.

There is an analogous case which may be referred to, in the "burning" of defective non-ferrous castings, a process obviously allied to fusion welding. The stresses set up in this case have been actually measured, and the manner in which this was done was as follows:

A stiff rectangular yoke of a material of which the modulus of rigidity was known was prepared and the metal for the burned in portion run in. The length of the yoke was then very accurately measured, after which the fused portion was cut through with a sharp saw. If this "burn" has been stressed, the length of the yoke will alter on the relief, and from that change of length, knowing the other dimensions, the actual stress to which the metal was subject is easily obtained. The case actually investigated was that for manganese bronze. The stress obtained in the test was 9,600 lbs. per sq. in., a figure which corresponds with the elastic limit. By calculation it may be shown that the stress which was to be expected was no less than 36,000 lbs. per sq. in. The difference is the result of the stress exceeding the elastic limit and so inducing permanent set. The effect is the same as if the metal had been subjected in tension to a load of 16 tons per sq. in. The serious effect of such stresses on a metal inclined to be brittle needs no further stressing. Now in fusion welding there can be no doubt that a similar state of affairs holds and that each such weld is internally stressed to an appreciable amount.

The hammering of a weld, if done properly, is a practice which is beneficial. If the temperature is high enough it performs a function not unlike that of forging, and results in the improvement which is seen when a cast metal is worked. The type of change which takes place may be realized from the following figures for tensile tests on a steel of the following composition:

Carbon, per cent	0.37
Silicon per cent	0.05
Manganese per cent	0.6
Sulphur per cent	0.05
Phosphorus per cent	0.05

	As Cast	Forged
Yield Point tons per sq. in	14	26
Maximum stress tons per sq. in	27	35
Elongation per cent	11	28
Reduction of Area per cent	13	47

Simple hammering may not give the full improvement here shown, but the change will be in the same direction.

When the temperature has fallen, however, a condition of affairs obtains which may render the hammering exceedingly dangerous. It is well known that at a temperature just below a red heat, iron and steel enters a range in which the brittleness is much increased, and in which the impact value and ductility are reduced. Working the material in this temperature zone readily leads to the formation of cracks. The following figures show the effect of this temperature on the impact value, a measurement which affords the best test of toughness, which we may here consider as the reverse of brittleness. This effect is spoken of as "blue-brittleness." The values of this impact value for an overheated dead-mild steel of the composition shown are collected in Table III.

Composition Per Cent

Carbon	Silicon	Manganese	Sulphur	Phosphorus
0.13	0.02	0.38	0.10	0.07

Table III

Temperature of Test C.	Izod Impact Value (Foot-lbs.)
15	2½
100	24½
200	21½
300	19½
400	18
500	15
550	12
600	14
650	14½
700	18
800	(30)

The danger of hammering at the blue-brittle temperature leading to the production of hair cracks will be clear from the figures quoted which are due to Greaves.*

Campbell in his "Manufacture and Properties of Iron and Steel," summarizes the effect of different elements on the welding properties of iron thus: "Sulphur" is "notoriously one of the worst enemies of welding." "With the exception of manganese in *small* proportion, the usual impurities in steel reduce its welding power. A small content of manganese aids welding." The explanation of this fact is probably to be ascribed to its influence on the sulphur which has already been dealt with.

Journal, Iron and Steel Inst. Carnegie Mem. 1923 *p.* 110.

GAS ABSORPTION BY LIQUIDS

Many liquids have a capacity for absorbing a certain amount of gas. The quantity thus absorbed varies with the liquid and the gas. Many gases, for example, are readily absorbed by water; thus, water will absorb its own volume of carbonic-acid gas, over two times its volume of chlorine, and 430 times its volume of ammonia. Water will not, however, absorb more than 5 per cent of its volume of oxygen. The weight of gas that a given volume of liquid will absorb is proportionate to the pressure, but as the volume of a given mass of gas is proportionately less as the pressure increases, the volume which a given amount of liquid will absorb at a certain temperature is constant, whatever the pressure. Water absorbs its own volume of carbonic-acid gas at atmospheric pressure. If the pressure is doubled on both the gas and water, the latter will still absorb its own volume of gas under the higher pressure, but, in that case, the density of the gas is doubled and, consequently, double the weight of the gas is dissolved. The quantity of gas absorbed increases as the temperature is lowered. One of the most important instances of the absorption of gases by liquids is met with in the absorption of acetylene by acetone; the latter liquid absorbs, at 60 degrees F. and 180 pounds pressure per square inch, 300 volumes of acetylene gas. This property of acetone makes it possible to safely store and transport acetylene gas in steel containers.—Machinery, July, 1924.

METALLIC ARC WELDING

Weld Should Stand Contracting Strains of Base—Proper Design Eliminates Weak Point—Study of Capabilities and Limitations Means Progress

By C. J. Holslag*

THIS subject is so important a factor in the designing of a weld that it is thought necessary to devote specific attention to it. Shall a weld be made to absorb all the stresses of warpage and bending, or shall it be deliberately made to pass these on to the rolled or forged parent metal?

Let it be remembered that an electric arc weld is a casting and, fortunately, a very good casting. By means of improved methods the weld may even be refined to the point of exhibiting the physical and chemical characteristics of the best grade of electric steel castings, which are considered the best. Nevertheless, except in some special cases, it seems fairly obvious that the weld deposit should not attempt to compete in strength with the rolled plate. This plate originally a casting, has been worked and rolled to a point where it has taken on properties which a plain casting cannot possess.

There is a fable concerning a dog that passed himself off as a wolf very successfully until he attempted to run with the wolf pack. So an electric arc weld casting is excellent as such, but cannot be classed with castings which have been rolled and worked. The same observation applies to any forged, stamped or pressed steel member.

In spite of this, the process of arc welding affords a superior means of joining rolled plates or structural forms. In welding steel or iron castings, it seems apparent at once that the principal result desired is the production of a stiff, solid joint, and that the weld shall possess those properties of elongation and ductility found in a good casting. Under these conditions all parts of the weld should be capable of withstanding the contracting strains of the base metal. Although, in arc welding, these strains are usually very small, they may sometimes be sufficient to produce a faulty weld. This is especially true when the weld is made "cold."

However, if the weld cools without cracking, there need be no apprehension as to the presence of locked-up strains therein. As a matter of fact, the act of stretching steel beyond its elastic limit (although not beyond its ultimate strength) actually results in an improvement in its physical properties of ductility and elongation. If this is so, then the stretching of a weld beyond its elastic limit produces beneficial effects in the weld itself, so that no matter how much the weld is strained, if it cools without breaking it may be relied upon. Most welds that crack do so during welding, or directly after, while the piece is cooling. The reason for this is usually that a cross section of sufficient strength to withstand the strains of cooling has not been provided. This brings us directly to the point to be emphasized, namely, that all electric arc welds should contain an adequate cross section and adequate stiffness, to be able to transfer all the strains which occur after cooling to the parent metal, which, supposedly, is better able to withstand these strains.

Although stretched steel is improved by moderate working, continued or intermittent stresses applied beyond the elastic limit will cause fatigue and complete loss of strength. Because of the fatigue tendencies of arc-welded steel, which are usually greater than those of worked metal, no live loads exceeding the elastic limit of the weld should be applied to it.

No riveted joint is designed to bend, and even the strongest of these joints—the double-butt strap—is certainly not capable of absorbing any of the bending strains within itself. This type of riveted construction is considered satisfactory for every use to which riveting is put; it would seem then, that the same type of rigid construction would be entirely feasible in a weld. If this is so, the costly and unproductive research for a rubber-like welding material is scarcely justified.

However, let us suppose that such a material were available; an ideal material that would contain all the physical properties of the best forged steel. Even with the use of this wonderful metal, the cross section of a weld should be made as large as possible. Elongation and deformation in a weld should always be avoided, because the most perfect weld is apt to contain minute flaws. To preserve a consistent degree of excellence in every weld, it is best to divert all strains as widely as possible, and not to allow them to be focused in the weld. All castings are subject to the presence of blow holes, gas pockets and many other imperfections and should be treated accordingly. A steel casting may contain a jet hole as big as a football and yet pass inspection; faults like these do not materially reduce the factor of safety. A poor weld casting is actually often better than a good poured casting.

Sometimes in live-load** welding an increase in cross section is not permissible in the member. In this case an extra strong steel weld should be used, or some mechanical means should be devised to conduct the stresses to the metal outside the weld. Like any steel casting, the weld may possibly contain internal flaws, and the chances are that these will occur at or near the boundary between the welded and parent metal, unless both are of the same material. This condition is likely to result in the presence of a weak spot, under severe continuous or alternating stresses. This weak point may be eliminated by so designing the weld that the stresses will be delivered into the parent metal. In operations upon cast iron the steel arc weld is a better joining medium than the base metal; hence a weld of this type may be made to possess the capacity of absorbing all the cooling strains, and thereafter to hold the casting in its previous rigid state through a link stronger than the original metal. In cast steel welding all the physical properties of the parent metal are easily duplicated and a practically homogeneous result assured.

In conclusion, we may assume that under advantageous condition a weld made with average care will withstand usual stresses with a strength about equal to that of mild rolled steel. Nevertheless, it is best to remember that a weld is a casting and always will be a casting, unless some method of forging is used. More progress may be made in the art of welding if its basic capabilities and limitations are frankly taken in account.

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*Chief Engineer, Electric Arc Cutting & Welding Co.

**We mean by live load in this article loads under alternating stress, such as revolving members. The live load members in building construction are considered dead load for welding purposes.

S. A. Gates, for 14 years in charge of the Spokane office of the General Electric Company, has been appointed manager of the Los Angeles office of that company. Mr. Bernhard Olsen, employed in the Spokane office for 12 years, has been appointed successor to Mr. Gates as manager of that branch.

VARIETY OF TORCH USES

Largest Industrial Firms on Pacific Coast Use Torch in Many Different and Profitable Ways

By C. W. Geiger

PRACTICALLY all of the large industries along the Pacific Coast use oxy-acetylene welding on quite an extensive scale, and many of the jobs which they find for welding and cutting torches are so unusual that a description of the work done in some of these plants may serve to suggest new uses to other firms.

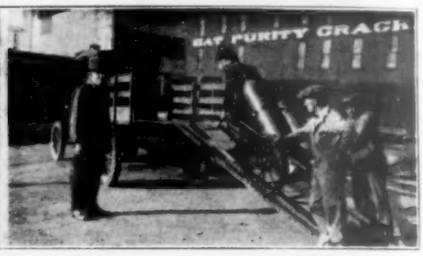
Lower Market Street in San Francisco having sunk in some places twenty-four inches below the official grade during the past fifteen years, it has been necessary to raise the street paving, street car tracks, high pressure hydrants, curbs and sidewalks. This gradual settling of the ground in this region was due to the fact that originally it was reclaimed by filling in the bay. The sinking is not confined to the street alone, but includes buildings and land in the vicinity. Since this land was reclaimed, there has been a great deal of heavy construction and a constant increase in heavy traffic.

The Engineering Department of the Market Street Railway is raising the two Municipal Street car tracks and the two Market Street railway tracks. The Board of Public Works is raising the street pavement, sidewalks and curbs, and the San Francisco fire department is raising the high pressure hydrants. The raising of the hydrants made it necessary to remove the individual shut-off rod from the hydrant body for the purpose of welding on an extension. This work was done at the Corporation Shops, operated by the fire department.

The first step in raising the hydrant was to remove the top, and pump the water out with a small pump. The hydrant was then unbolted at the base and hoisted by the means of a special wooden horse, 9 ft. in length and 8 ft. high, which carried a chain hoist on a trolley. After the hydrant was raised, the pavement was removed over the area extending from the hydrant to the main line gate in the street. Excavations were then made to a point below the hydrant branch leading from the main to the hydrant so that the branch could be unbolted from the main line and the lead burned out of the joints. Acetylene and gasoline torches were used for the purpose of burning out the lead. The arrangement used here was to attach a long pipe to the hose leading from the torch which was placed on the pavement near the excavation. A burner was attached to the other end of the long pipe and the operator burned out the lead from the joints by standing or sitting on the edge of the excavation. The branch was then raised from the ditch and new fittings were installed to bring it up to the proper grade.

Horses Used to Raise Hydrants

Melting Out the Lead



Loading the Welding Outfit for a Hurry Call

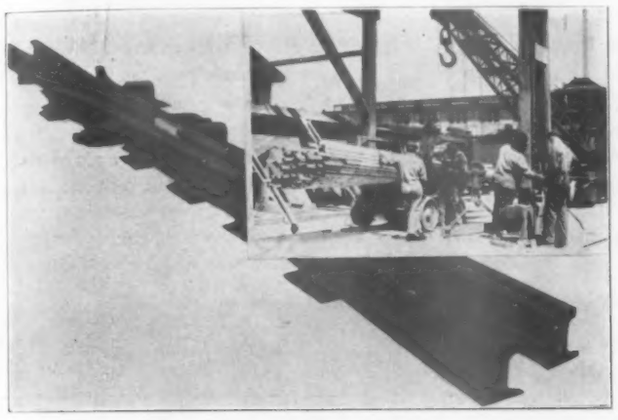
All welding of the street car tracks on this work was done by portable welding equipments. In the raising of the street car tracks, the Market Street Railway Company removed the old rails and designed new ones especially rolled for the new installation. Track work was carried on at night because the headway between street cars is only about twelve seconds during the rush hours, which is too short to allow any considerable work. Between the hours of 11:45 P. M. and 5:45 A. M., all passenger cars are kept off two of the four tracks. By using a permanent cross-over, it was possible to turn back all in-bound cars and keep part of the way open for continuous work. Portable welding outfits are kept mounted on hand trucks so that they are readily transported by means of Ford trucks from one location to another.

Scrap Sorting Dock, Where Thousands of Dollars Are Saved to the Railroad

Modern railroad efficiency methods are well exemplified in the way the Southern Pacific Railroad Company economizes by getting additional use out of materials which have been discarded as worn out and useless. This company would have had to draw nearly a million dollars from its treasury to purchase the material reclaimed in a single year at the price of new material. When reclaimed it was good, usable material fit for another period of service. This does not include the material which was

sent in for the purpose of being repaired and returned to service, such as air brake material, valves, pumps, remounted hose, axles, wheels, injectors, etc. The big saving of material which otherwise would have been wasted is not a reflection on any department, but a credit to all of them because various departments assisted in searching out material and turning it in. A great deal is reclaimed at its source, and there is no data to show values in these cases.

Much of the reclamation saving is accomplished through the use of the welding and cutting torch. The mechanical department is reclaiming and returning immediately to service many items which formerly when worn or broken had to be replaced by drawing from new store stock. Examples for such items reclaimed now by welding are piston heads, worn collars on car and tender axles, flanges on driver wheels, chafing irons, foundry flasks and cracked cylinders.



Ninety Pound Frog with Welded Point Ready for Service. Insert Shows Trucks Delivering Flues to the Shop

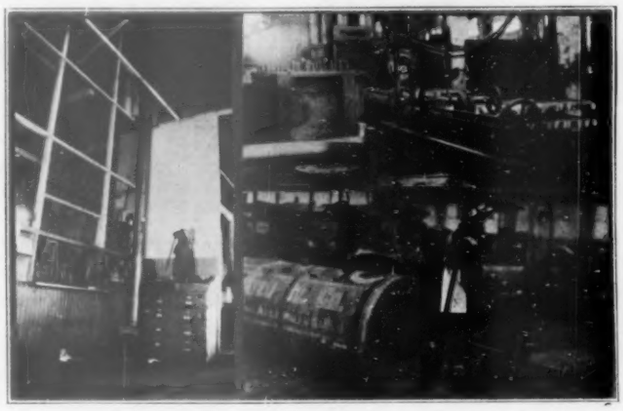
The maintenance of way department is building up track crossings and frogs while in the track; greatly extending the service of these units and saving the expense of making changes in the installations.

The articles reclaimed at the repair shops cover a wide range. Much of the material received is made over in an entirely different form, and even the machinery used in the reclamation work has itself been reclaimed. The items handled vary from tin drinking cups to bolts, brake beams, car and locomotive couplers, truck and body bolsters, rail joints, switch points, frogs and rails. Supply trains pick up all such material on the line each month. It is gathered all along the right of way, brought in and sorted at the central scrap docks at Los Angeles, West Oakland, Sacramento and Portland. The officials know that everything which has been discarded may still have some usefulness, so nothing is overlooked. The men working at the scrap docks (great piles of scrap of all kinds) are usually men who have been with the company for a long time and are experts in every line. They know just what the department is reclaiming when the material found can be reclaimed, and the nature of each article they find. Much scrap metal is sold, and to get the best price, it is sorted very carefully. So the men at the scrap docks have to know when they are dealing with wrought or malleable iron, cast iron, rolled, forged or hammered steel, structural steel, etc.

Southern Pacific men have responded very heartily in this reclamation work, and it is now hard to find scrap of any nature on the right-of-way between fences. There are large savings made in the reclamation of single articles. At Sacramento in one month, seventeen 80-pound switch points were reclaimed. The cost new would have been $22.70 each. The cost of welding labor, plus the value of the switch points as scrap metal average $4.97 each, a saving of $17.73 each or $301.44 for all the switch points reclaimed in that month. In the same month at Sacramento, 117 car couplers were reclaimed. The value of these couplers new would have been $2,647.06, and the cost of reclamation, including the value of the couplers as scrap, was $870.23, or a total saving of $1,912.50—about $16.34 each.

Superheater units are reclaimed by renewing return bends or applying new ball joints. The bends are formed out of scrap and are welded into one continuous pipe. The ball joints are turned out of bar stock. A projecting lip engages the end of the unit pipe, holding the work on center during the welding process. The unit joint is finally polished with a carborundum cloth, held in a cup-shaped chuck, attached to an air motor. Gauges are used on all points and seats to insure proper contour. When finished the unit is tested at 250 pounds hydraulic pressure.

Wrenches are salvaged by welding broken parts, straightening up and sharpening the jaws, applying new screws, butts and handles. Scrap boiler tubes are used for a number of purposes. Defective portions are cut out and the good parts welded together for water drain lines, air lines, conduits, locomotive pilots and



Left—Well Casing Made Into Air Tank. Upper Right—Cutting Piston Rods. Lower Right—Cutting Holes in Oil Tanks

freight car ladders. Scrap car roofing is made into tinware, smoke jacks ventilators, shop lockers, etc. In fact the reclamation shops and docks at Sacramento and Los Angeles are constantly offering new service to the mechanical and stores departments. Mechanics are constantly discovering new kinks or short cuts in preparing material, lowering costs which have previously been prohibitive, and discovering new methods for the use of material which previously could not be reclaimed.

Some of the field divisions of Associated Oil Company have welding outfits, but few keep a welder in their employ. Until

Showing How the Three Pipes Were Welded to the Main, the End of Which Was Also Welded Shut

recently the Midway division had an outfit which was kept in a locker and used occasionally by some "would be" welder in welding a small casting or cutting trench plates for gas engine houses. All heavy work was sent out to a nearby town, but a great many castings found their way to the junk pile, as the cost of welding in many cases was excessive.

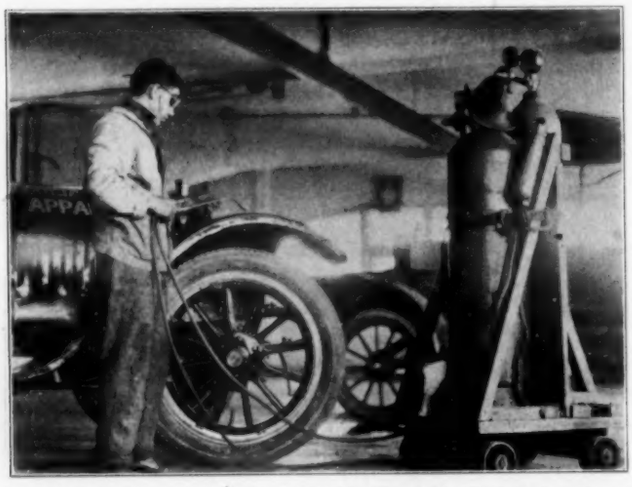
Recently a man was hired who was willing to act as blacksmith's helper and do what little welding was necessary. In a

short time he became so proficient that no casting was thrown away until he had given it the "once over," and the shop foreman, who is interested in developing his men and securing any equipment that will make them more efficient, soon found it necessary to take him off the blacksmith work and fit up a place where he could give all his attention to welding. A lime pit was made for annealing; a preheating furnace for gas engine heads; an underreamer furnace built where underreamer cutters could be preheated and hardened. The company feels more than justified in making these improvements by the interest aroused and the results obtained.

Recently a new process has been developed in this shop that should be of value to all engaged in deep drilling. As all operators know, where underreamers are in use, after repeated dress-

Six Cables Were Welded to the Ground Plate to Secure Perfect Contact

ing back of the underreamer cutters, they become so short and out of shape that they must be replaced. It was suggested that he try out a new idea; that of building up the worn surfaces of the cutters by welding on cast iron instead of dressing them back in the old way. The idea was good, but they were not satisfied with the results,—the cast iron wearing away too quickly. He then suggested welding on tool steel and tempering in water. This solved the problem. As an actual fact, the wearing qualities of the built-up cutters is equal to the original steel, not only giving long service, but retaining their original shape and never



Sturdy Cylinder Truck Used in Pacific Gas and Electric Co. Shops

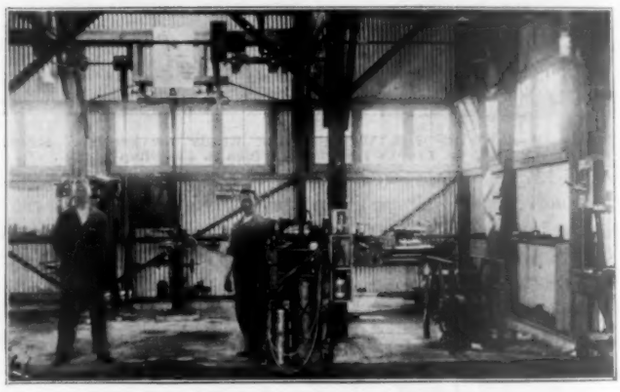
causing trouble in going down through the casing, as has been proved by over a month's service.

At the plant of the Associated Oil Company in San Francisco, a section of oil well casing welded at both ends and set up on end is used as an air tank. A pressure of from 140 to 160 pounds is carried and this casing carries this pressure with safety. It is set up in one end of the room and takes up very little room.

In driving piling for the foundation of the new Pacific Gas & Electric Building in San Francisco, the city permitted the high-pressure water system to be used by the contractor to "jet" the piles downward when driving was difficult. This system functions by means of a water pipe that runs down the side of the pile and flushes the hard material from under it. The water was delivered to the water pipe by welding three pipes to a large main extending from the high pressure hydrant. These pipes were then connected up with the outlets on the high pressure hydrant as shown in the accompanying photographs.

The Pacific Gas & Electric Company have recently completed in San Francisco a class A structure of reinforced concrete, the auto repair shop, store room and division machine shops for repairing and maintaining the large number of automobiles and motor trucks used in the San Francisco division of the company. This same building also houses the department for repairing the electric and gas street lights. The portable welding equipment used in doing the welding in the automobile repair department is carried on four wheels, and as a safety precaution a fire extinguisher is carried at the top of the rack. The tanks are held in the upright position by a heavy rope passing around the wooden racks which can be quickly loosened for removing the tanks.

It is sometimes very difficult to obtain a perfect connection with the earth, especially in certain places where the soil is dry. As the area of the ground plate is increased however, the chance of some part of it always being in contact with wet earth is increased, especially when the plate traverses several strata of soil. In an effort to get such a perfect earth connection at the Pit River Power Plant of the Pacific Gas & Electric Company a



Portable Welding and Cutting Torch Used in Machine Shop of San Francisco Board of Public Works

large steel plate measuring 20 feet by 8 feet was buried in the earth under the tail race and to it were welded six cables which let to the transformers.

Municipal repair shops and garages are maintained by the cities of San Francisco, Oakland and Los Angeles, all of which are equipped with extensive welding equipments.

At the municipal machine shops in Los Angeles, where repairs are made on the automobiles and trucks of the following departments: police, health, playground, park, fire department, building departments, municipal market, public utilities, humane and other lesser departments welding is used in many ways.

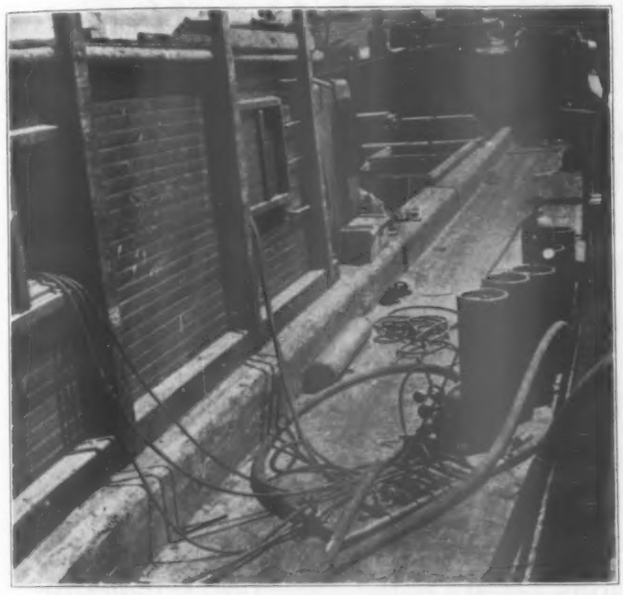
The blacksmith shop is equipped with two forges, a power trip hammer and a furnace for spring work, and heat treating and case hardening. In these shops a number of five-ton steel trailers were turned out for the engineering department, to be used in hauling asphalt. Every part of the trailers were made at the shop with the exception of the front axles.

There is a large galvanized iron building which houses an erection shop, motorcycle repair shop and the salvage department. In the erecting shop there is a shear for heavy sheet metal, and a portable oxy-acetylene welding and cutting outfit, that is used extensively in repairing electric light posts, fire and police alarm posts, etc., which frequently are damaged by motor trucks. If the repairing to be done to a post is very extensive, it is taken to the shop, otherwise the outfit is mounted on a truck and taken

to the post. Repairs can be made for about one-third the cost of a new post.

All sheet metal work is done in the lamp and radiator reapir department. In this department there is a large testing tank for testing radiators and tires. A compressed air tank is connected with the radiators, which are placed in the testing tank, and if there are any leaks, the compressed air escaping shows just where the leaks are. A gas torch is maintained here for repairing the leaks. Chain blocks are mounted over the testing tank for lifting the heavy radiators.

These shops have built a truck for the fire department which carries a portable oxy-acetylene cutting torch, which is carried in a metal case about 2 feet high and 18 inches square and is of



Showing Manifold in Deck of Steamer and Also Welding Equipment on the Deck of the Vessel

such a weight that two men can carry it readily to any point for use. The torch cuts readily half-inch boiler plate at the rate of a foot a minute, ⅞-inch steel bars at the rate of eight a minute, and will cut through iron as thick as 4 inches. A cylinder of commercial oxygen and one of acetylene gas are carried in this case, equipped with the necessary gauges and 25 feet of tubing and all necessary tips and wrenches. The capacity of the tanks is suffiicent for operating the torch for seven hours.

One of the photographs shows the welding and cutting equipment which is used in the machine shop which is operated by the San Francisco Board of Public Works in connection with a machine shop, and blacksmith shop, in making repairs on all automobiles and motor trucks and equipment of the street repairing department, and street cleaning and sewer departments. The machine shop and blacksmith shop are housed in a building constructed of corrugated iron. The welding equipment being installed on a truck can be quickly taken to any part of the yards for doing welding work. The department of electricity and the fire department both maintain extensive machine shops, which are well equipped with welding equipment. The city of Oakland operates a municipal garge and machine shop where are maintained and repaired all of the automobiles used by the various city departments. Complete welding equipment is installed in these shops for doing all welding that may be necessary.

A very novel service has been installed at the San Francisco water front by W. R. Grace Company by means of which they furnish compressed air and steam to a number of docks along the waterfront, which is used by various steamship firms in making minor repairs to their vessels, thus making it unnecessary for the vessel to go to a shipyard.

W. R. Grace Company operate an oil plant near the dock and use steam and compressed air extensively in their plant, and they conceived the idea of extending the steam and compressed air pipes to the docks, where they furnish hose and manifolds so that a number of lines can be operated at once. The accompanying photographs show the hose and manifold and also shows the welding equipment on the deck of the vessel. The compressed air is used in operating the various machines such as riveters, reamers, etc., aboard the vessel and the steam is used in operating the auxiliary machinery aboard the vessel, while repairs are being made to the boilers.

The service is greatly appreciated by steamship firms at San Francisco, often enabling them to make minor repairs by using the services of the crew.

There are four oxy-acetylene welding outfits in the sheet metal department of the Don Lee Automobile Sales and Service Building in San Francisco. This department is provided with special wooden horses for repairng the fenders and radiators. Each horse is provided with a vise for holding the fender while the operator works on same. Templates of all fenders are kept on hand by means of which it is easy to bring the metal fenders back to their original shops.

CARNEGIE INSTITUTE ESTABLISHES RESEARCH BUREAU OF METALLURGY

As a further step in the plan to expand its scientific research facilities, announcement is made by the Carnegie Institute of Technology in Pittsburgh of the establishment of a special Research Bureau of Metallurgy to begin its work the first of September, 1924. The express object of the new department, it is reported, is to apply to metallurgical questions the recent discoveries in the field of physics and chemistry.

The organizing of this new bureau is the second important development concerning metallurgical research that has been reported during the year at the Pittsburgh institution. The first step, it was previously announced, was the adoption of a definite program of investigations in metallurgy to be made by the Department of Metallurgy at the Institute in co-operation with the U. S. Bureau of Mines. Several college graduates have already been appointed to Fellowships by the Institute authorities to carry out the program of research problems, the investigators to have the financial aid and assistance of an advisory board of metallurgical engineers and steel manufacturers of Pittsburgh in addition to the co-operation of the Bureau of Mines.

Attention is called to the fact, however, that the new Research Bureau of Metallurgy just organized will be a department established separately from the research investigations carried out by the Department of Metallurgical and Mining Engineering in co-operation with the Bureau of Mines.

Dr. Francis M. Walters, Jr., has been appointed Director of the new Bureau and Dr. Vsevolod N. Krivobok, has been appointed as an assistant, according to an announcement by Dr. Thomas S. Baker, President of Carnegie Tech. The appointment of another assistant, a specialist in X-Ray work, will be made during the summer months.

As Director of the Bureau, Dr. Walters will also have the title of Professor of Experimental Physics. For the past two years he has been connected with the U. S. Bureau of Standards in Washington, D. C. as Associate Physicist, and he has had a wide and varied experience in the teaching field as well as in the field of applied physics.

The members of the new bureau, says the announcement, will devote their time almost exclusively to research. At first the work will be entirely of a theoretical nature but it is expected that as progress is made, the study of a certain number of practical questions will be undertaken.

President Baker went abroad early in June to vist some of the laboratories in Europe with the special view of securing some information which may be utilzed in this new metallurgical work.

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USING THE ARC WITH SAFETY

Methods of Protecting Eyes and Bodies of Electric Arc Welding Operators—Safeguarding Apparatus

By D. H. Deyoe*

IN electric welding and cutting certain precautions have to be taken for the protection of the operator and those working near him, and for the safeguarding of machines and buildings. These may be classified as follows:

1. Protection of operator's eyes from the dangerous rays of the arc.
2. Protection of operator's body from sun burns caused by the dangerous rays of the arc.
3. Protection of operator's body against burns from hot metal.
4. Safeguarding the health of the operator.
5. Protection of others working in close proximity to welder.
6. Protection of operator from electric shock.
7. Fire hazards.
8. Protection of welding apparatus and its control.

Radiation from an electric arc may be divided under three headings:

1. Invisible infra-red rays.
2. Visible light rays
3. Invisible ultra-violet rays

The electric arc passing between iron electrodes is rich in visible and ultra-violet radiation, and the amount of energy consumed in the arc makes the total energy radiation more than the eye can safely bear at working distances. The intense glare given off from the arc contains all of these rays and the operator has to be protected against their harmful effects.

For light welding, face shields containing light colored protective glass and in some cases goggles alone, fitted with similar glasses may be safely used.

For heavy electric welding or carbon cutting, the operator's eyes should be protected, either with a welding helmet or with a face shield, those to be provided with a darker shade of protective glass selected to suit the welder.

Welders lenses should be very carefully selected. Lenses that transmit only bands of color separated by dark absorption bands are undesirable, being liable to produce eye-strain. The transmission spectrum should be continuous, as shown in that of Noviweld. It should not extend too far either into the red or the green, and it should absolutely cut out all blue and violet light.

Spectrum No. 1 shows—Full continuous spectrum of light from a 250 watt Mazda lamp.

Spectrum No. 2 shows—Transmission spectrum of above lamp through Noviweld lens. The Noviweld lens has been considered the Standard of Excellence in welder's safety glasses for many years.

Spectrum No. 3 shows—Transmission spectrum of another safety glass on the market, which resembles the Noviweld very closely.

Spectrum No. 4 shows—What may be termed an ideal spectrum, which covers just that portion to which the eye is most sensitive, thus giving the clearest definition of the work in welding operations, with the least amount of glare. This ideal screen has been made only with colored gelatin, which is affected by the heat radiated from the welding, and is therefore unsuitable for continuous practical operation.

Spectrum No. 5 shows—Transmission spectrum of a welder's glass which shows an undesirable dark band of absorption in the orange and yellow.

Spectrum No. 6 shows—Transmission through a gelatin screen showing still more absorption in the orange, yellow and green.

All exposed parts of the body are subject to a burning effect from the rays of the arc. This burning is similar to a sunburn and if the body is not protected by covering of some kind, it will cause the operator more or less discomfort or pain. For ordinary welding the welder's body is usually covered by close woven clothing and the hands by leather gloves.

In heavy arc and carbon welding and carbon cutting where currents of 200 to 1000 amperes are used, it is necessary to protect the operator still further. With these heavy currents the arc rays will penetrate the ordinary clothing and it is customary for the operator to wear a large well fitting leather or asbestos aprons, protecting as much of his body as possible.

The greatest danger of injury to the operator comes from this source. These burns may come from either the operator picking up hot parts just welded or from flying particles of molten metal lodging in some part of his clothing or more often in the tops of his shoes. The necessary protection for these are heavy leather gloves always to be worn to protect the operator's hands while handling hot parts and protectors to be placed above the tops of his shoes to prevent molten metal from lodging there.

When using the arc for heavy welding or cutting, or where welding or cutting is being done on non-ferrous metals or galvanized materials, or materials that are oily, it is very desirable to provide ventilating ducts or fans to carry away the smoke and fumes. If the operator is allowed to inhale these more or less poisonous fumes, his health will sooner or later be impaired. It is also desirable, in safeguarding the health of the operator, to at all times, provide him with a well lighted and well ventilated room.

To protect nearby workers from eye flashes, opaque screens should be placed between the welder and the workman. Or a better arrangement would be to enclose the welder in a welder's booth shutting off all the flashes from the surrounding part of the factory. It is desirable to paint the side walls and all apparatus in a welding booth or a small room used for welding with a paint that will absorb the dangerous rays of the arc. A satisfactory paint for this purpose may be made from zinc oxide or Chinese white mixed with glue water. This will dry with a smooth unglazed surface. If this is not done, the operator or nearby workers may be subjected to eye flashes from the side, even back of a welder's face shield, or to the burning of the back of the neck or ears of those not directly facing the arc.

Where many welders are working on small parts, it is customary to build a series of small booths with open tops and curtained backs. These small booths are usually provided with a bench on which parts are welded and necessary control apparatus for the convenience of the welder in regulating his arc.

With the ordinary low voltage direct current welding, it is not necessary to pay much attention to the protection of the operator from electric shock. With alternating current welding using transformers and high voltage direct current welding from trolley circuits using resistors, either voltage limiting switches or cutouts should be provided for protecting the operator against shocks in handling his work or changing electrodes.

The fire hazard from electric welding is not great, due to the fact that the operator is always present and on his guard against

*Industrial Engineering Department, General Electric Company, Schenectady, New York.

small fires that may be caused from sparks or flying moulten metal. A welder's room should at all times be kept free from litter such as oily waste, papers, or any inflammable material.

Welding apparatus is designed along standard lines and is safeguarded by circuit breakers, contactors, fuses, enclosed switches, enclosing boxes for control apparatus, insulated couplings, gear cases, insulated holders, etc.

Editor's Note—An article under this title appeared in the June issue of The Welding Engineer. It was not correct in all respects. The folliwng article by the same author and covering the same subject is now published in corrected form as his latest work on this topic. The previous article was from a paper presented before the National Safety Council in Detroit, June 12, 1923. The article here is from a paper read before the same Council in New York, January 22, 1924.

PIPE WELDING COURSE

By Reg. K. Randall

The Cleveland School of Technology has just finished a very interesting course in "Pipe Welding." The men who made up the class were representative steam fitters for the most part. One, however, was employed by a large gas company and another took it up in order to go into the oil fields.

The course was started with a series of lectures on gasses and apparatus used in oxy-acetylene welding, neutral flame and its relation to a good welding, fusion and penetration, the cutting torch and its uses, the selection of filler rods and tips, various

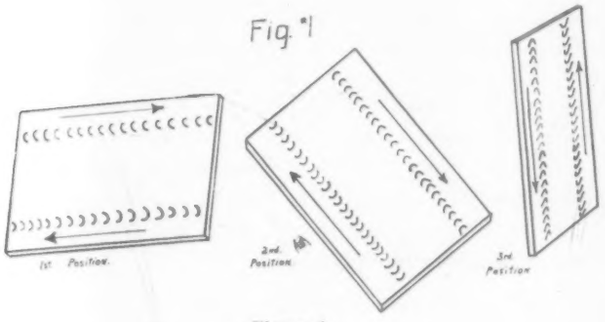


Figure 1

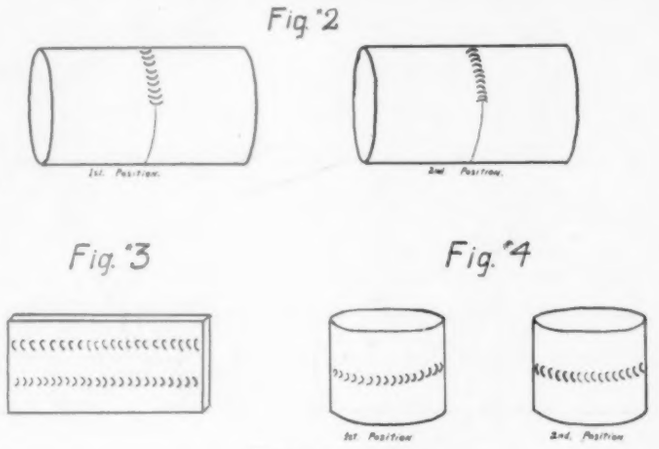
makes of torches and pressure used for same, how to make your own template, do's and don'ts. In conjunction with the regular evening lecture, other subjects of course came up which were duly discussed in class.

The actual torch work started with a lesson in making and maintaining a neutral flame and was followed up by lessons in "fusion" on ¼ flat steel. The steel was gradually raised at its left end until it was perpendicular. The direction of laying on the beads was alternated as the angle increased, one layer from the bottom up and one from the top down. (Fig. 1.) As soon as the class mastered these exercises they were taught how to handle the "cutting torch" great care being taken to secure uniform "bevels" and straightness of cut. Old 4 inch boiler flues were then cut to make a simple "butt weld." These welds were made to fit in with the flat exercises, from the top down to the middle on one side then turn the flue and weld from the middle to the top. (Fig. 2.) Upon completing a welded section of pipe it was taken to a block and hammered with a 12 pound sledge until either the weld or the pipe broke. None of the first few welds were any good, the fusion usually being on one side only. It was of interest also to note that fusion was not always on the same side usually alternating first being on one side and then on the other. However, this breaking and showing faults helped a lot and after one or two trials the work improved rapidly and welds were soon made that stood great distortion without breaking.

The next few lessons were on the flat ¼ steel the "beading" being done this time in a horizontal position first from right to left and then from left to right. (Fig. 3.) This lesson was then applied to the 4 inch boiler tubing and the same hammering and breaking process used to show up faults. (Fig. 4.)

Once more the flat steel was used, this time actual welds were made. "Tee" welds were made at different angles and then broken. The "tee" welds incidentally were found to be the hardest to master. (Fig. 5.)

The making of templates was taken up next. The theory was first explained and then actual projections were made of various angles of 6 inch pipe. Great care was taken that each man



Figures 2, 3 and 4

thoroughly understood this important phase of "pipe welding." Many shops of the smaller class do not have a drafting room to prepare their templates and time can be saved if the welder on the job can lay out his own work.

After this, sections of 6 inch pipe were furnished the men and actual welds were made, each man laying out his own work, cutting it and then welding. The pipes were raised on the welding tables and welded together one quarter at a time, the first quarter being uphill and the next quarter down and so on until the weld was completed.

No attention was paid to an actual "tying in" welds until the

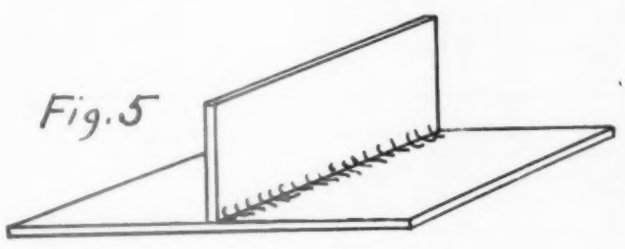


Figure 5

end of the course and the class was doing some real welding. Before making this type of weld the men were given practice overhead on flat steel.

The course took 65 hours, we had 100 per cent attendance and the men felt capable of doing real work.

One little sidelight I feel should be mentioned to show that welding schools are entitled to a great deal of support from the manufacture of gasses and apparatus. Two installations were made of oxy-acetylene welding apparatus as the direct result of this course, both by small firms incidently.

In conclusion I wish to say that the "special course" as we called it was a success both from our point of view and the men's. We also want to take this opportunity to thank Mr. H. E. Wetzell of the Cleveland firm of Smith & Oby and the Cleveland Office of the Linde Air Products Co. for the kind assistance they gave us in helping to make the course a success.

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VOLUME 9 JULY, 1924 NUMBER 7

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Safety or Sorrow

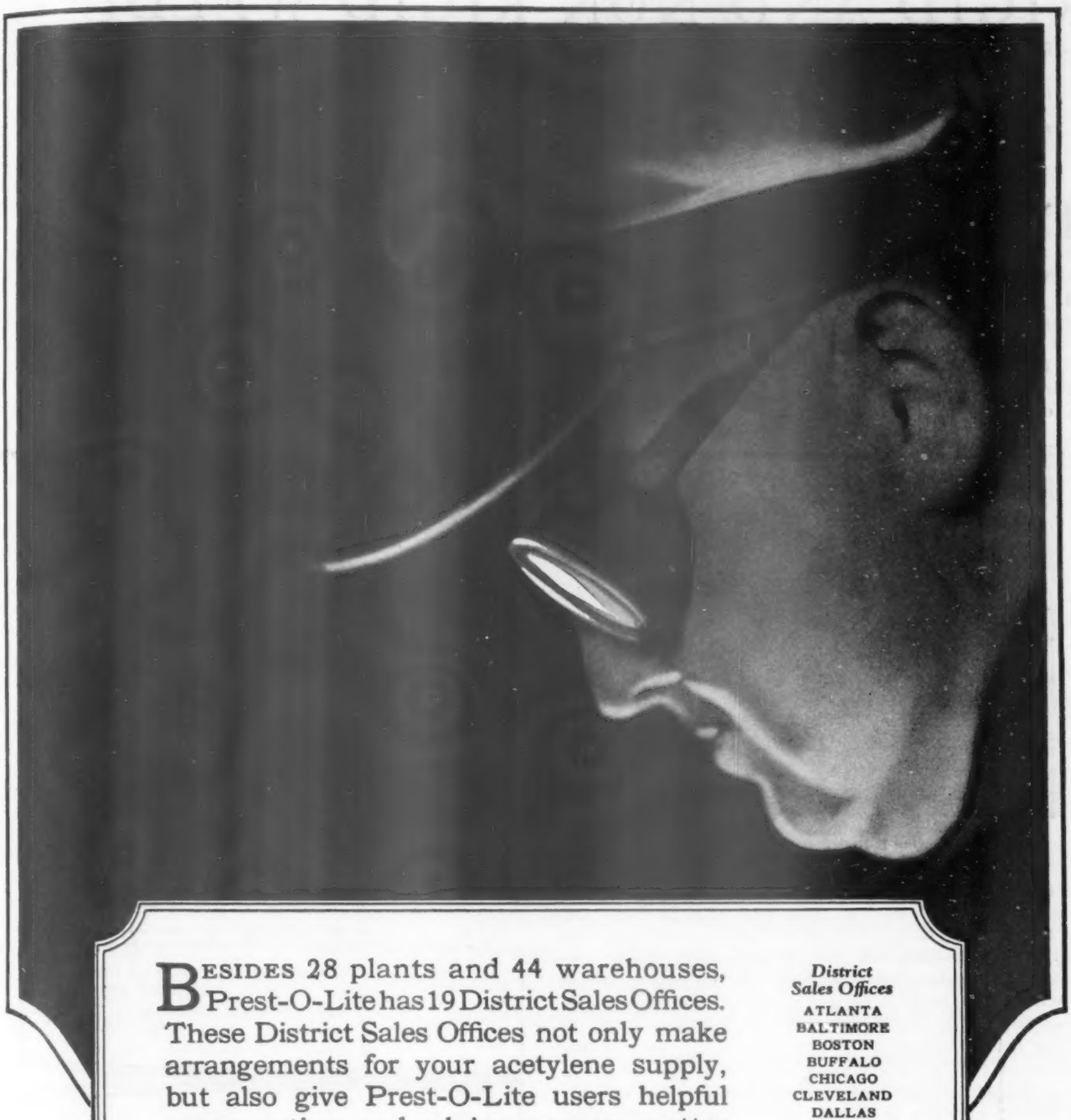
S O S, is the sign painted everywhere throughout the city of Chicago by the Boy Scouts in the drive for safety in street traffic from automobiles and other means of transportation. This is an excellent idea and an excellent slogan. It would be hard to find a more fitting one and one which would apply not only to traffic safety but to all kinds of safety. Safety in the welding shop is imperative if sorrow is to be eliminated. Too much cannot be said about safety in industrial work, and in the welding field where high pressure gases and high current welding outfits are in constant use, safety is the one thing that will do away with the unecessary sorrow. Be careful in the matter of transporting cylinders and heavy castings and machinery. Be careful when cleaning acetylene generators and when working around them and installing them. Be careful in all shop work, that instructions of operations are carried out to the very letter and that all of the necessary safeguards and precautions have been taken. Keep your mind on nothing but the work to be done for if you always are on the watch to see that everything is all right before you go ahead, there will be more safety and less sorrow. You know the question of safety would not come up if everyone would always do the right thing at just the right time and not try to rush something through when it shouldn't be done. It is the same in the welding shop as it is on the conjested street corner, if you wait till the officer gives the signal you can cross in safety, for you are in the right place, doing the right thing at the right time, but if you hurry across the street in the middle of the block, when traffic is heavy and moving in both directions at once, you are bound to get hurt and be sorry you were not more careful, unless you are very fast on your feet. It is a mighty fine idea for the foreman of a welding shop to have conspicuous "Safety or Sorrow" signs tacked up in various places for the idea is so catching it is bound to do a lot of good.

More Home Made Ideas

H OME made equipment is an idea that clings lovingly to the inventive members of the welding fraternity. Home made acetylene generators continue to spring up here and there, in spite of the educational work that is being done by manufacturers and insurance companies. Now the idea is spreading to arc welding apparatus. Some are trying to use constant potential battery charging generators for welding, some to build their own a. c. transformer or reactance set, or even generators. There is more to arc welding than striking an arc that will melt a piece of wire, and arc welding apparatus must be built by engineers who know what electrical characteristics to give it. Start right in using a new process by installing equipment that is built for the purpose.

Associations

M ANY people consider associations in the wrong light. They think that an association is merely a price and policy fixing organization from one end to the other—That the small men and the individuals are entirely out of the picture. Such is not the case—for such practice is not only against the law but against the normal healthy growth of the association. By this growth can be measured the worth of the association, and very happily, all of the Welding organizations do show this growth and usefulness to a marked degree.



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RIGID AND NON-RIGID WELDING*

Flexible and Rigid Methods of Preparation—Right Welding Speed Eliminates Warping—Make Welds Rigid

By J. C. Lincoln†

THERE is a great deal we do not know about what happens when a weld is made by the carbon arc process. The same is true of a weld made by the metallic arc process. There are some things we do know.

1. The heating of the metal is very rapid; as the arc progresses along the joint, the metal that is melted is raised from room temperature to at least the melting point of steel in a fraction of a second. At this elevated temperature, some action takes place that propels the metal from one side of the crater to the other. The metal is propelled from the

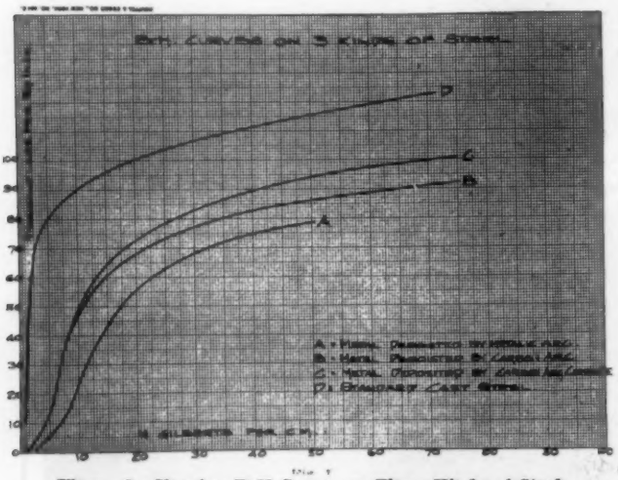


Figure 1. Showing B-H Curves on Three Kinds of Steel

side of the crater that the arc is approaching to the side of the crater the arc is leaving. This force transfers from one side of the crater to the other 15 or 20 lb. of steel per hour when an arc of about 300 amp. is used under proper conditions. The action of the metal in a carbon arc, as well as the action of the metal in the metallic arc, can be explained on the assumption that steel at freezing temperatures or at the melting point dissolves large quantities of gas and that the capacity of steel to retain gases in solution decreases rapidly as the temperature of steel is increased. As an analogy, the capacity of water to dissolve ammonia gas is very great at 0 deg. C., the melting point of water. At this temperature it will dissolve nearly 2000 times its volume of ammonia gas. As the temperature of the water is raised its capacity for holding the gas in solution decreases until at the boiling point of water, practically all the gas has been driven out. The metal in both the carbon and metallic arc acts as if gas was evolved in or behind the heated metal and this acts as a blast to propel the metal from the hot side of the crater to the cool side, and from the metallic electrode to the work, even when the work is above the electrode as in vertical welding.

2. It is clear that in either the carbon or metallic arc the metal is raised in the fraction of a second, roughly 2000 deg. C. It is also clear that the temperature of the metal after it has passed across the crater in the case of the carbon arc and across the arc in the case of the metallic arc falls with extreme rapidity. The rate at which the metal cools is much lower than the rate at which the temperature is raised, but even then the temperature of the metal falls with the same order of rapidity that the temperature of metal falls when it is quenched in water.

The practical question is what kind of metal have we in the weld after it has passed through the arc? The assumption is sometimes made that this metal is ordinary cast steel. In some respects this assumption is not justified by the facts.

The tensile strength of the steel after it has passed across the crater is almost equal to that of the original steel. Unfortunately, the ductility of the weld metal is not as great as the ductility of a good, ordinary cast steel. It is my opinion that improvement in the art of electric arc welding must be made in the direction of increasing the ductility of the weld metal. Another indication that weld metal is not ordinary cast steel is the fact that it will not stand up under prolonged heating at a bright red heat or above nearly as well as the ordinary steel casting.

Several years ago, in an effort to get additional information on the nature of weld metal, the writer had test samples made up from which the B-H curves could be made up. One sample was made of metal that had passed across the metallic arc and another sample of metal that had passed across the crater of the carbon arc. These samples were turned down so the final size was ½ in. in diameter and 10 in. long. Mechanically the metallic arc sample was superior to the sample made by the carbon arc. There were a number of gas holes in the carbon arc welded sample which reduced the effective cross section at least 10 per cent. The samples were treated by the Case School of Applied Science and the results are shown in Fig. 1. Curve A is the B-H curve for

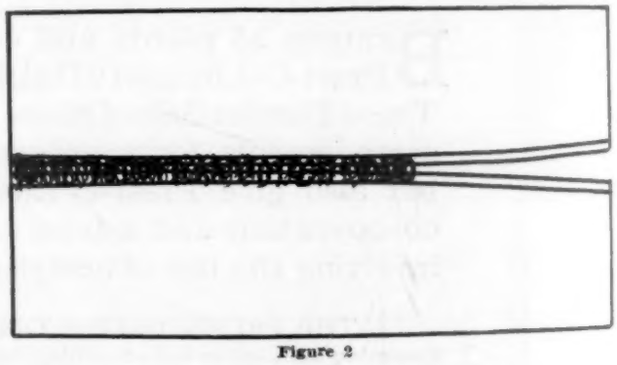
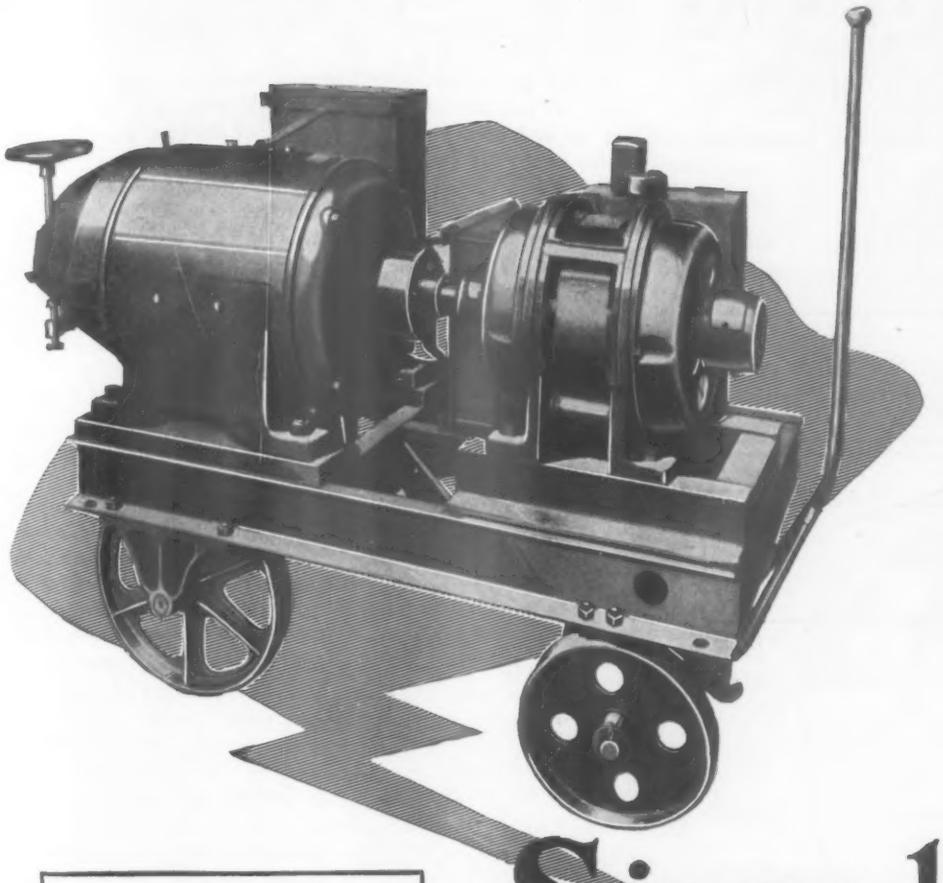


Figure 2

the metallic arc sample. Curve B is the B-H curve for the carbon arc welded sample. Curve C is an estimate of what Curve B would have been if it had been free from holes and mechanically equal to the metal in Curve A. Curve D is the B-H curve for ordinary cast steel.

To my mind these curves show that the molecular structure of metal after it has crossed a metallic arc or passed across a carbon arc crater is quite different from the molecular structure of cast steel. It will be seen that these curves are similar to that of a pile of thin sheet iron discs made into a pile ½ inch in diameter and 10 inches high. It looks as if the iron particles were separated by something in the same way that the metal on the adjacent discs is separated

Paper Read at Meeting of American Welding Society.
†*Vice-President, Lincoln Electric Company.*



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by a layer of oxide. Attention should be called to the fact that the B-H curve for the carbon arc welded metal is better than the metallic arc welded metal. My explanation of this fact is that the metal in passing from one side of the crater to the other in the carbon arc process is not heated to as high a temperature as the metal is heated in passing across the metallic arc. The practical result of all these considerations is that in the present state of the art we cannot expect metal of the high ductility in the weld metal and that it is not to be expected that this metal will stand repeated bending as well as metal of a different structure and that, therefore, the

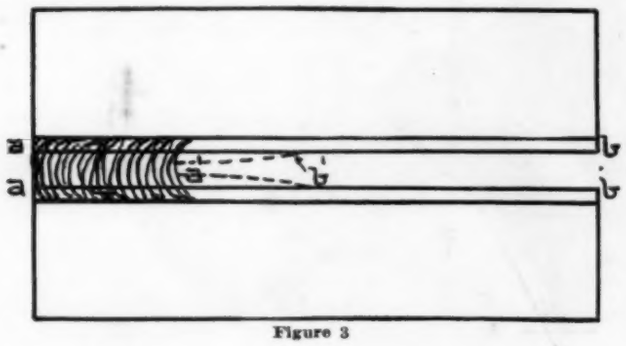

Figure 3

welds must be made so as to throw any bending strains outside the weld.

In other words, the weld must be made rigid so that any possible bending will occur outside of the weld. Therefore welds should be made rigid and not flexible.

Flexible and Rigid Methods in Preparing for Welding

I understand it is the general practice in gas welding to start the welding of two plates with an opening at the far end of the plates. As the welding proceeds these edges are drawn together by the contraction of the metal in the weld and plates as they cool. The same method is very often used in welding by the metallic process. What happens to a couple of plates when the edges are welded together depends on the expansion in the plates near the arc, due to the local heating. The strains set up by this local heating are hard to follow completely and it is likely that they are controlled by a number of factors. I will briefly discuss two factors which control to a great degree the strains in the plate and, therefore, dictate to a great degree the proper method of welding. It seems to me to be a safe statement that the locked-up strains in a weld are more largely due to the heating and cooling of the plate than to the cooling of the weld metal. The best study of locked-up strains in welds can best be made by studying welds in cast iron. The volume of melted steel is about 7 per cent greater than the volume of the same metal cold. There is, therefore, about the same shrinkage in the weld metal when welding cast iron as when welding steel. The tensile strength of cast iron is about one-third as likely to produce a crack in the iron as in the steel. The greater ductility of the steel as compared with cast iron greatly increases this ratio. Experience in cast iron welding shows that heating of the edges of the plates to be welded must be reduced to the minimum in order to prevent cracking due to cooling strains. It is impossible to prevent the cooling strain due to the cooling of the melted weld metal, but experience shows that it is possible to do very difficult cast iron welding if care enough is taken to avoid excessive heating of the edges of the plates to be joined. This is done by welding half an inch or more and then letting the weld and plates cool before doing any more welding. The shrinkage of the weld metal is the same whether the cast iron is welded continuously or in short steps waiting for the metal to cool between steps. The local heating of the cast iron is less in the step by step method and the fact that the step by step welding produces a weld in cast iron less liable to crack indicates that the heating of metal adjacent to the weld is, in this case, the determining factor between a good and a bad weld.

In the continuous welding of a joint between two plates there are two chief actions—one tending to close the plates at the far end of the weld and the other tending to open these plates at the far end.

Fig. 2 is a sketch intended to show that any heating of the edges of the plates ahead of the weld pushes this metal toward the other plate. After the weld is made, cooling of the plates, as well as cooling of the weld metal tends to draw the plates together and thereby draws the plates at the far end of the weld together. That this action exists is generally recognized by the common practice of leaving the plates farther apart at the far end than at the weld.

Fig. 3 shows what would tend to occur if the weld between two plates was made all at once as it is by the thermit process. In this case it is clear that the plates would have a tendency to open up at the ends.

It is evident that if the weld could be made quickly enough from one end to the other, that the same effect would appear. The question whether the plates tend to approach each other or to draw apart as the welding progresses is, therefore, determined by the time required to make the weld. If the weld is made slowly enough the effect shown in Fig. 2 will determine the result, for with slow welding, there is greater heating of the metal and, therefore, greater expansion ahead of the weld. Also, the expansion of the metal behind the weld becomes more general as soon as the heat is evenly distributed through the plate, and therefore, the effect shown in Fig. 3 decreases. On the other hand, making the weld rapidly decreases the heating, and therefore, the expansion of the metal ahead of the weld, thereby decreasing the effect shown in Fig. 2 and at the same time increasing the effect shown in Fig. 3.

Experience with automatic carbon arc welding shows that a speed of about 1 foot per minute, the effect shown in Fig. 3, is greater than the effect shown in Fig. 2, and that the plates open up as the weld progresses.

When the welding operation started the two plates were in contact. The ends are about $\frac{3}{16}$ inch apart after welding.

The conclusion is, therefore, that if the right speed of welding is selected that the effects shown in Figs. 2 and 3 may be made to balance each other and thereby eliminate warping.

ANDIRONS MADE FROM OLD GEARS

By T. R. Evans

There is more than one way to get money out of the scrap pile if the welder is clever enough to fabricate old pieces of metal into shapes which can serve some useful purpose. These little sketches show how a couple of old Ford axles and ring gears were made into a pair of fire dogs. We simply bent the axles as shown, cut the ring gear in half and welded the pieces

A Use for Old Gears

together. The result was an attractive looking article which was very easy to make. Probably a better looking set could be made by using a spiral gear from one of the larger cars if one happens to be available. It would be very easy to make this quite a fancy job by painting with aluminum, bronze or gilt paint. A still more elaborate job can be made by cutting initials or designs out of scrap plate with a cutting torch and welding them on.

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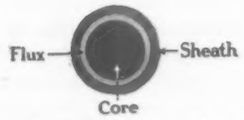

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PROGRESS REPORT OF COMMITTEE ON ELECTRIC WELDING

E. Wanamaker, Chairman, Electrical Engineer, C. R. I. & P. R. R. F. J. Hill, Chief Electrician Michigan Central R. R. C. E. Murrey, E. E., Grand Trunk R. R. C. T. Goddard, General Foreman, Electrical Department, I. C. R. R. Ernest Lunn, E. E., The Pullman Co. E. H. Hagensick, E. E., Union Pacific R. R. J. C. McElree, E. E., Missouri Pacific R. R. R. C. Gage, E. E., Canadian National Rys. A. M. Frazee, E. E., Duluth, Missabe & Northern Ry. Co.

To the Members:

Your committee begs to report that three meetings of the committee have been held in Chicago with fair average attendance, considering the heavy demands being made upon the time of the electrical men at this period of the year. The consensus of opinion has been such that the committee is making to the Association the following recommendations:

In view of the fact that the electric arc welding process has some time since passed the experimental or development stage and has become a recognized commercial art or practice, it is deemed extremely advisable for this association to compile an electric welding manual. The design and manufacture of electric welding equipment and the installation of same has been treated by the Electric Welding Committee each year for the past several years; also some work has been done on the application of the process.

The manual, as proposed, should start with a foreword explaining the chief reasons for the compilation and existence of such a manual, with the proper explanation to the effect that the Electric Welding Committee will be a standing committee and each year its work to consist of such revisions as are necessary work to maintain the manual up to date.

In this case, it is felt that the manual should cover the forms of electric welding processes used in railway work, including arc welding, both metallic and carbon, spot welding and resistance welding. The manual to be so indexed, possibly using the method of indexing of the American Locomotive Company, that the manual may be used as a book of ready reference for the entire art. It is realized that it would not be possible to make a complete manual during the year 1924; however, it is recommended that a progressive start be made and work to continue into 1925, issuing the manual either in part as completed with the necessary additions, or complete the same in 1925 according to the decision to be arrived at after the report is made at the Annual Fall Convention.

It is probable that the *first* section of the manual will consist of a description of the various electric welding processes and their general use. The *second* section to consist of recommended methods of installation. The *third* section to consist of recommended methods of application covering first the typical jobs and important jobs that have already had their successful application demonstrated by years of service, including detail instructions for the training of operators.

The last section to consist of description of application of such jobs as are being experimented upon or such jobs as are undergoing development in so far as the welding application is concerned.

It is the intention on all such practices as have not been thoroughly tried and developed into a standard, to send out proposed methods or practices to various railroads, obtaining the opinions of the various mechanical and welding officers so that no practice will be recommended that has not been demonstrated and approved. This, in order, that the manual may be so compiled that it may be looked to for safe advice or recommendation to guide the users of the art in their daily work. Of course, it is to be understood that such practices as are recommended would be one safe way of performing the work, and the user is not necessarily limited to the recommended practice.

From time to time as better practices are developed and proven, bulletins, or new sheets, will be issued.

We already have collected the nucleus for compiling this manual, which the committee feels should be of the loose leaf type, preferably of standard letter size with the back or hinge on the side. As it becomes necessary to issue new bulletins, those replaced may be removed and the new bulletins inserted, or in case of additional bulletins, they may be inserted in their proper place according to the index. The type of indexing proposed will enable the users to quickly find under group headings any particular class of welding application desired, each group subdivided into individual jobs of that particular kind or class.

It is also the intention of the committee, in the foreword, to call attention to the importance of the part the operator's skill plays when applying the autogenous welding practices.

It is further recommended that sections on electric arc cutting, rivet heating, and electric furnaces, be included in the manual.

If the recommendations hereto suggested are approved by the semi-annual meeting, the committee will arrange to proceed with the compilation of the manual.

Respectfully submitted,

Committee on Electric Welding.

CONFERENCE ON SIMPLIFICATION OF TANKS.

After representatives of tank manufacturers, distributors, and consumers had made studies of sizes, working pressures, and other factors connected with pneumatic tanks, cold water storage tanks, gasoline, fuel oil, and distillate tanks, active steps were taken on Wednesday, Thursday, and Friday to bring about eliminations of unusual shapes and sizes of these products through the co-operation of the Division of Simplified Practice, Department of Commerce, under whose auspices meetings of the interested groups were held.

Eastern interests in each case prepared tentative recommendations which are to be submitted within the next few weeks to Western manufacturers as a basis for further progress. This was a preliminary action, the Eastern group stated, which will enable an agreement to be reached at the Western conferences which will probably be held in Chicago.

In the case of the cold water, pneumatic, and hot water storage tanks, representatives of the American Institute of Architects, the National Association of Master Plumbers, the American Engineering Standards Committee, the United States Chamber of Commerce, and other national groups were present and were consulted, while the group studying tanks for private water systems was addressed by Miss Miriam Birdseye of the Department of the Agriculture Extension Service. Miss Birdseye told the manufacturers that the Department of Agriculture is keenly interested in furthering any plan which will enable the farmers of the United States to install modern appliances, and she expressed the view that the conference was a step in that direction.

Among the tentative recommendations adopted by the group studying pneumatic tanks was the grading of six sizes of vertical and nine horizontal tanks. The former included 16x36 inches, 16x48 inches, 20x60 inches, 24x60 inches, 30x72 inches, 36x72 inches; and the latter 36x120 inches, 42x120 inches, 48x120 inches, 48x240 inches, 60x252 inches, 72x288 inches, 48x240 inches, 60x252 inches, 72x288 inches. It was also voted that 85 pounds working pressure should constitute the standard rather than test pressure; and that for sizes up to and including 36x120 inches, gauge glass should be 12 inches with 13½ inch centers and for larger sizes gauge glass should be 20 inches with 21½ inch centers. These tentative plans, it was stated, represented a reduction from more than 100 varieties.

The cold water storage tank, it was brought out, in 75 per cent of cases, is built on specifications furnished by architects or persons other than the tank manufacturers. There is no standard, and frequently square or rectangular tanks are specified, when the round type would be from 20 to 25 per cent cheaper by reason of reductions in stocks and other expenses

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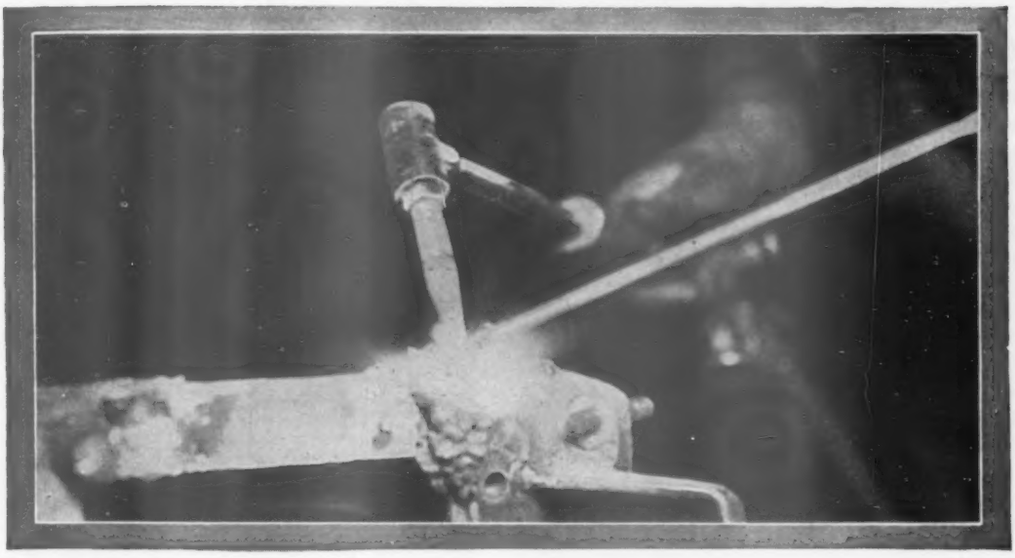

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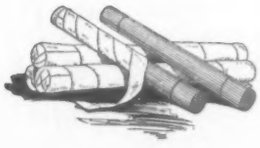

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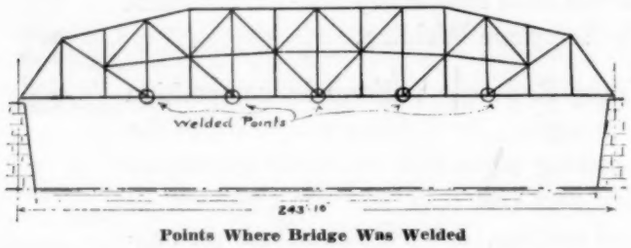
under the present system. LeRoy Kern, of the American Institute of Architects, told the group he believed architects would favor a simplified line of such tanks and that he would be glad to present the recommendations of the conference to the Institute. The group proposed recommendations to be sent to other manufacturers of house tanks, calling for vertical installations of non-pressure tanks with flat bottoms in capacities ranging from 1,500 to 20,250 gallons, and sizes from 5 feet diameter and 5 feet in height to 15 feet in diameter by 15 feet in height. These will be discussed by other manufacturers and brought up at a general conference later.

Fire departments of various cities and representatives of the National Fire Protection Association and the National Board of Fire Underwriters were represented along with other groups at the conference on the simplification of gasoline and fuel oil storage tanks. The recommendations included limitation to 12 sizes as follows: 280, 550, 1,000, 1,500, 2,000, 3,000, 4,000, 5,000, 10,000, 12,000, 15,000 and 20,000 gallons, these applying to tanks shipped assembled. It was also suggested that in all fuel storage tanks of 1,000 gallons or greater capacity, manholes be installed to provide for cleaning out and thus increase safety. Reviews of manufacturers' lists showed from 30 to 150 different types, sizes and capacities of tanks for storage of gasoline, fuel oil, and distillate. Battalion Chief Edgar B. McKnew of the Baltimore Fire Prevention Bureau furnished considerable detailed information as to safety features and methods of installation, on which recommendations could be based.

WELDING IN BRIDGE REPAIR

An operation of interest to the engineering profession in general and structural engineers in particular was recently completed in the reinforcing and building up of bridge members eaten away by extensive corrosion. The bridge in question is located at Pittsburgh over the Allegheny River, connecting Herrs Island with the North Shore and is a 240 foot through truss, pin and linkspan, built about 31 years ago.

The floor of the bridge was carried on timber stringers sup-

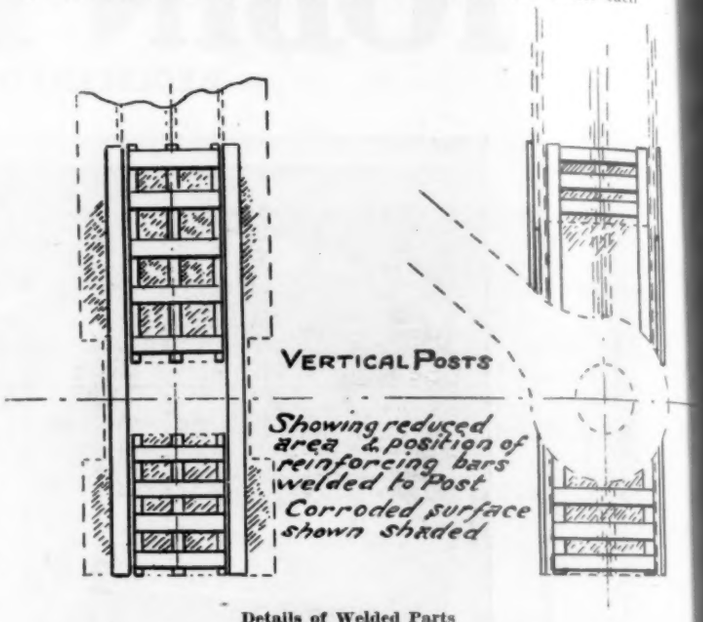


Points Where Bridge Was Welded

ported on cross timbers bolted to the web of the floor beams. While the upper portions of the structure are still in a good state of preservation, the parts rendered inaccessible to paint and kept constantly moist by the proximity of the timber were so greatly reduced in section as to be perforated and, in many places, almost severed. The webs of the floor beams and bottom of vertical posts suffered particularly, being reduced from 3/8 inch in thickness to 1-32 inch over a large area.

It was decided to renew the entire floor by cutting away the floor beams and sidewalk brackets from their connection to the vertical posts. This operation presented no very unusual difficulties. The strengthening of columns, however, was a more serious problem. These were compression members built of Z-shaped bars and web plate, and directly above and below the pin the bearing plates were found to be perforated and reduced in section over 60%.

The difficulty was overcome, both economically and efficiently, by welding, using the electric arc metallic process and employing a General Electric 200 ampere motor-generator set. The method adopted by the Pittsburgh Welding Corporation, under the supervision of the engineering department of the city of Pittsburgh, was to weld strips of steel, 1 inch by ½ inch, extending from the bottom of the column to a point well beyond the corroded portion. After the surface of the original metal had been thoroughly cleaned by use of the acetylene torch, scrapers and wire brushes, the bars were welded into position vertically, and tied together at close intervals with crossbars of the same section. After each



Details of Welded Parts

point was completed, the strength of the weld was tested by subjecting the bars to a number of blows with an eight-pound maul. Results of physical tests showed practically no deterioration of the original metal when welded by this process.

ELECTRIC MELTING POTS HAVE AUTOMATIC TEMPERATURE CONTROL

An electric melting pot for melting and maintaining at working temperature soft metals and alloys such as solder, babbitt, lead and zinc is one of the recent developments of the Westinghouse Electric and Manufacturing Company. This melting pot, which is made in two sizes, of 150 pounds and 750 pounds capacity, has a thermostatic control that automatically keeps the temperature of the molten metal at any desired point between 450 degrees and 950 degrees, Fahrenheit. A small electric motor controlled by a thermostat throws the snap switch on or off as the temperature of the metal reaches the high or low limit set by the operator, and an even working temperature is assured without further attention.

The melting pot is unusually well constructed. The heating element and all its connections are mounted on the melting crucible, which can be easily lifted out of its outside casing to make the element accessible. The outside casing surrounding the crucible is lined with an adequate layer of heat insulating material to reduce radiation losses and insure cool shop conditions. The control panel, which may be mounted in any convenient position, consists of magnetic contractors and suitable relays for opening and closing the line circuit. An instrument panel, which is set up adjacent to the pot, contains the thermostat with temperature regulating pointer, the push button switch for turning the current on or off, and a red signal lamp which serves as a warning in case the heat is left on accidentally.

Out of the great advantages of the electric melting pot is that it permits the use of lead base babbitt rather than the tin base alloy. Lead base babbitt is much less expensive than the tin base and forms an equally good alloy, but it is greatly affected by either overheating or pouring too cold and therefore can only be used where it can be poured at a constant, accurate temperature. With the temperature control possible through the use of electricity for heating, the pouring temperature can be so closely regulated that the use of lead base babbitt is made possible. Thus, a substantial reduction in the cost of babbitting is effected.

COURSE IN ELECTRIC WELDING

How Course Is Conducted—What It Covers—Actual Work Develops Sense of Responsibility

THE training of men in the art of electric welding is now recognized as being quite as essential in obtaining good results in that craft as is the training of men in the arts of metal and wood working. In any line of manufacturing the workman must become thoroughly familiar with tools and their proper use in order to be efficient. For these reasons, the General Electric

Where Electric Welders Are Taught

Company maintains, at its Schenectady plant, a school for the training of electric welders, originally established for the Emergency Fleet Corporation.

Courses in this school are recommended to cover a period of from eight to ten weeks in duration, such training in practical welding being necessary thoroughly to prepare a man for electric

Welded Benches Made by Student Welders

arc welding work. The time required usually depends to a large extent on a man's previous experience.

The process of welding by means of an electric arc, or arc welding, as it is commonly called, is adapted to many applications where iron and steel are to be joined, built up or cut. Practically all arc welding is accomplished by one of two methods, referred to as either the metallic or carbon electrode method. In either case, the process utilizes the heat of an electric arc formed between the electrode and the object to be welded. The arc melts a small pool of metal on the work and, in welding or building up, additional metal is deposited in this pool in a molten state, thereby forming a firm union between the old and new metal. If the operator is not trained to hold the arc steady and at a uniform distance, instead of a complete fusion of the metal there will be a series of cold spots resulting in an extremely weak union. This alone is responsible for more failures of welds than any other cause.

The General Electric Company extends the service of its welding school to all its customers without charge; transportation

Student Welder on the Job

and living expenses are paid by the students themselves or by the company they represent. A large number of students have received instruction in this manner, many industries and government agencies having sent their employes to Schenectady for instruction.

The training course follows the general outline recommended by the American Welding Society and, as the student masters the fundamentals, he is advanced to more difficult operations. The student is required satisfactorily to complete each exercise before passing on to the next and is allowed sufficient time for each. Entering students are assigned to a booth containing a work-bench or table and each one is shown the proper position to take while working at the bench. He is carefully instructed in the use of proper equipment for the protection of his face and eyes, and other necessary equipment is furnished him and its use described.

For a time, the beginner is given an opportunity to watch an experienced welder. In this way he observes the motions used in striking the arc and moving along a weld. His ear becomes accustomed to the sounds of the arc, both when it is too long and when it is of proper length. He is then given an opportunity to practice the motions of striking the arc, first without current and later with current. He is cautioned against allowing metallic electrodes to "freeze" or stick to the work and his

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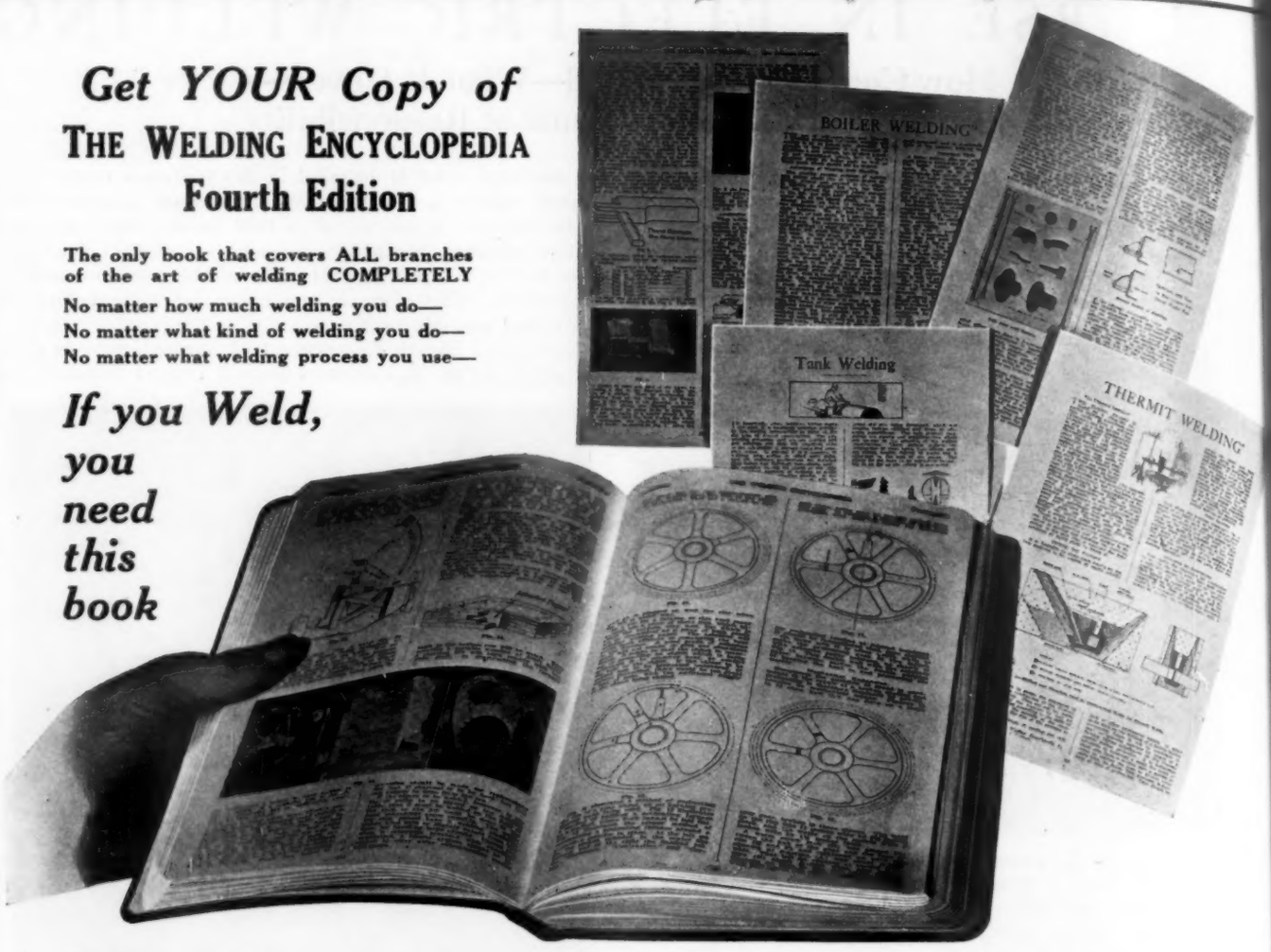

THE WELDING ENCYCLOPEDIA, Fourth Edition
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It serves every possible need for information on all of the welding processes. Whether your shop is engaged in production welding or repair welding, or both, whether you use the processes for only one metal or for a variety of different metals and different types of joints, **The Welding Encyclopedia** furnishes you with expert advice which pays for itself by increasing the quality of your work. **The Welding Encyclopedia** is not restricted to the welding knowledge that can be imparted by a single writer. On the contrary, each subject is discussed by a recognized authority on that particular subject. About fifty of the best known authorities on welding subjects in the world have contributed the results of their experience and research along special lines.

In compiling **The Welding Encyclopedia** the editors have had put at their disposal a vast fund of information which could not be made available through any other source. The result is a single volume covering the entire range of problems which can arise in the application of any of the welding processes, and this information has been so carefully arranged and cross-indexed that any portion of it is instantly located.

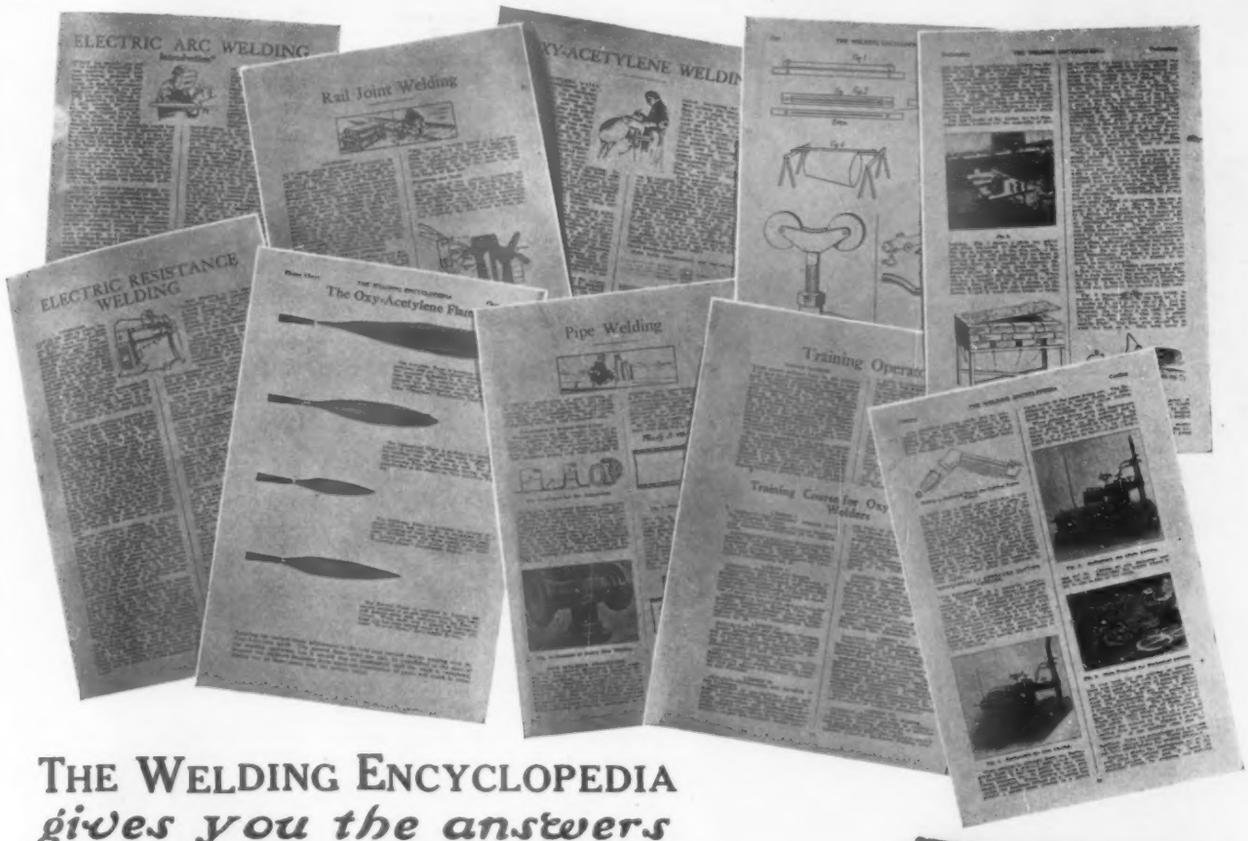
The Welding Encyclopedia describes in detail the theory and practice of every welding process, and tells how to weld every weldable metal by each of these processes, giving detailed instructions for handling such important welding jobs as boiler welding, sheet metal welding, tank welding, pipe welding, automobile welding, cutting, rail joint welding, railroad welding, etc.

It tells how to prepare parts for welding, how to preheat, how to anneal, how to test welds and how to select welding material. It explains the meaning of all words and terms found in welding literature. It gives the trade names of all products used in the welding industry, giving the name and address of the manufacturer in each case.

It tells how to take care of welding equipment so as to get the best results from it and keep maintenance costs down. It gives the latest revised federal, state and insurance rules and regulations for the installation of welding equipment, and its application to important work. There is also a splendid collection of charts and tables used for welding information, grouped together for convenient reference.

A valuable feature of The Welding Encyclopedia is the chapter on the training of operators. This chapter outlines lessons, exercises and examinations for a complete course in both oxy-acetylene and electric arc welding. Throughout these instruction courses references are supplied to the instructor and student so that they may find instantly the portions of the text which cover the topics in the outline.

The text is profusely illustrated with photographs and drawings made especially for **The Welding Encyclopedia.** No detail has been overlooked which could make The **Welding Encyclopedia** complete and practical.



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The editorial office of **The Welding Engineer** is recognized as the headquarters for authoritative information and help on all branches of welding, and conducts a large volume of correspondence helping welders and welding departments out of their difficulties. In a period of eight months it was found that 95% of the problems submitted to this office were answered directly from the pages of **The Welding Encyclopedia.**

Think of the time all these welders would have saved by providing themselves with a copy of **The Welding Encyclopedia** in advance! **Don't wait** until you get into trouble, or run up against a hard welding problem, but get the information in your hands **now.** Then, when you want it, it will be instantly available.

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The table of contents below can give you only a very general idea of the scope of this work. Send for the book and give it a careful examination. We guarantee that it will be fully satisfactory and if not we will cheerfully make a refund. **Send the coupon today.**

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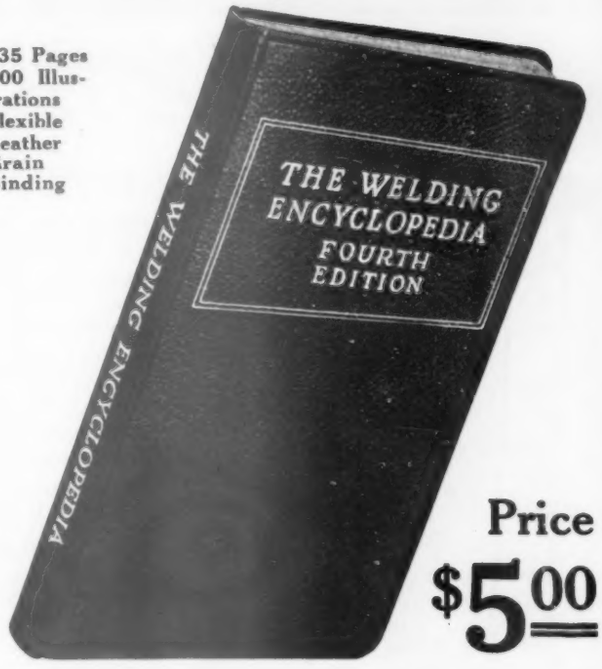

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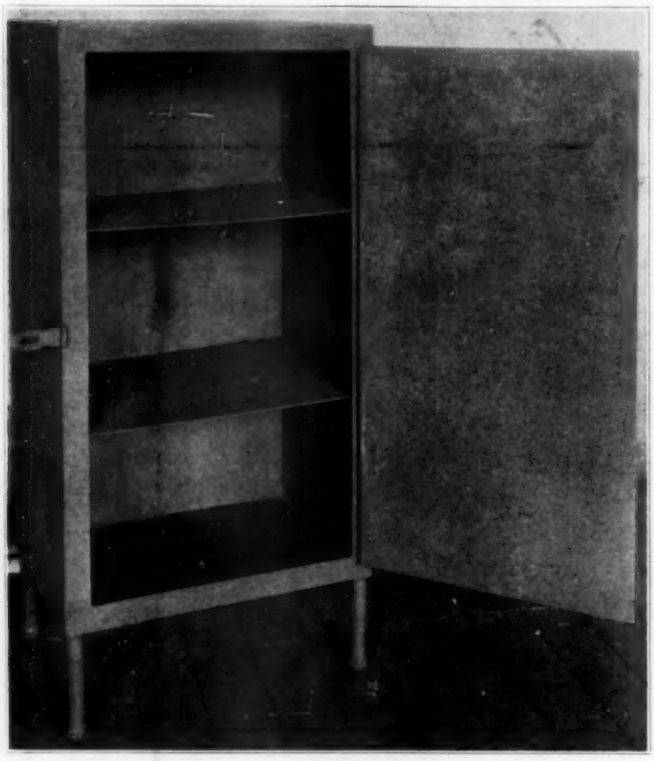
instruction continues until he is able to start and hold an arc consistently.

After the student is able to start an arc and hold it uniformly for a short time, the exercises take the form of lessons with



Cabinet Welded by Students

certain conditions laid down and certain requirements to be met by the finished weld before the student may pass on to the next lesson.

Welded Ladder Made in School

The first group of lessons teaches the student to hold a proper arc and to deposit sound metal on plates in various positions. The lessons are preliminary, to a certain extent, although some of the welds are used in practical welding. The lessons which follow deal more with actual welding operations.

A great part of the student's time is devoted entirely to instruction in the use of the metallic electrode for welding steel. The general principles and methods followed are applicable to simple welds of structural or forged steel, wrought iron, plate steel and for cast steel having a carbon content below 0.40%. The remainder of the student's time is taken up by instructions concerning the use of carbon and graphite electrodes.

After the student has successfully completed the entire series of exercises, it is by no means supposed that he can be conduction work. He is accordingly put to work on a number of applications of arc welding designed to develop his own ingenuity and judgment. Various courses of instructions are given in the welding of different metals and the student is shown the many uses to which arc welding may be put in repairing, building up worn parts, cutting, etc. Students are also given an opportunity to make a special study of that work, if any, in which they intend to specialize.

Various exercises in the training course emphasize certain difficulties encountered in production welding and repair work, such as welding locomotive flues, tank joints, cast iron repair jobs, overhead welding, etc. Opportunity is allowed in many cases for the student to work in various shops in the General Electric plant. By thus coming into contact with different classes of work, the operator is given an opportunity to acquire experience and acquaint himself with some of the conditions which the practical welder must meet satisfactorily. This method assists in developing a sense of responsibility and promotes that quality which should be instinctive with every good welder, and which is known as "job pride."

JAMES DUNHAM NOW IN EUROPE

James W. Dunham, son of M. Keith Dunham of the Oxygen Products Company, Chicago, Illinois, sailed for Germany on June 12th. Jimmy is a Junior in the Massachusetts Institute of Technology where he is pursuing a chemical engineering coursse. His father is sending him to Germany to study the German language as well as chemical engineering. While in Germany he will be under the guidance of Mr. Adolph Messer. Jimmy's trip will not be confined strictly to study. He spent five days in London with Capt. D. Richardson of the Northampton Polytechnic Institute. In a letter to his father Jimmy tells about seeing all of the tennis stars of the World in the recent Wimbledon matches. He also saw the King and Queen of England and many other notables. From London he is going to Frankfort and then to the Olympia games. It will certainly be a wonderful trip and experience for him and a broad education in itself. It will fit him for future work as an associate of his father in the oxygen business. He will return to this country on October 1st to resume his studies at Boston Tech.

James W. Dunham

BRAZER OR FOUNDRYMAN?

By Kut-off

Dear Editor:

Seems like I haven't written you in a long time. I'm still alive and kicking and working for Bill. Also I've spent a lot of time going to school, nights, so maybe that's why you haven't heard from me. But my letters from now on will show that I've learned something in school and that's what counts with me. When I look over some of my letters I have to laugh at the funny breaks I used to make. Guess I was like a lot of other fellows who handle the torch and are classed as hunkies because they can't write or speak the language without murdering it.

I'll admit it's no cinch putting in a hard day over the torch and then making the day perfect by trying to keep from falling asleep while somebody explains why I shouldn't say one thing when the other thing is the right one to say, or how to spell a word that I had no idea at all of ever using. Maybe it wouldn't be a bad idea for a lot of other fellows who are in the same boat I used to be in, to do the same thing. I don't regret the hard work and I'm certain they won't.

As for my welding. Well, I've improved a lot, and even Bill tells me I'm getting there. In fact, he lets me handle jobs he'd never have thought of my trying about a year ago and it is one of these I'm writing to tell you about now.

Some time ago a chap dropped into our place with a heavy copper piece made up as I have shown in Fig. 1 and told me he wanted a thin steel shield brazed to it around the part indicated by the dimensions. The cross section shows how it was to be done.

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As I understood it, this piece of copper was to be used in an electric soldering iron and on a job which uses a flux that corrodes the copper pretty badly. The idea was to protect the copper from the flux. This meant that a perfect bond had to be made and at the same time the protecting shield was to fit very closely to the copper.

Well, it nearly phased me, and the man admitted it had him stopped. He was an engineer in a plant where they had several expert brazers and all of them had fallen down on the job because they could not keep the copper hot enough without burning the steel or scaling it so badly that it opened up in spots. And the steel was mighty thin and couldn't be increased in thickness as it would spoil the heating properties of the instrument.

They had managed to run the brass part way down but it bulged the upper part of the shell and left cavities all around the sides with no brass at the bottom at all.

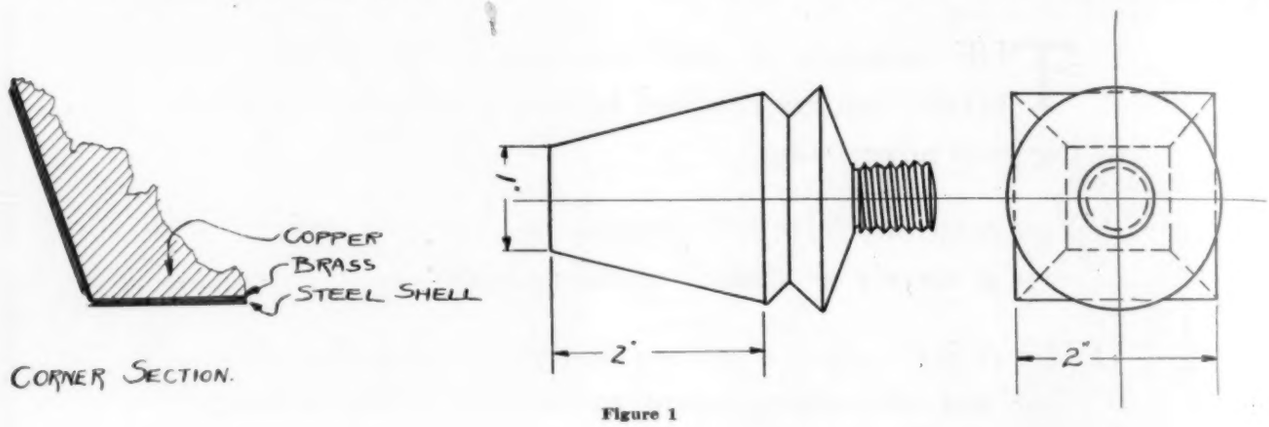


Figure 1

I welded up a shell from some steel that he had brought along already bent and cut to size and tried the same stunt as his men had tried. That is, I put the steel shell on the copper after I had brought the copper up to heat and tried to run the flux and brass into the spaces. No luck. So I pulled off the steel, cleaned the copper and sat down to think.

And the idea came. Why not make a crucible of the shell, partly filling it with molten brass and flux, and then force in the copper keeping it up to heat and well fluxed?

So you won't have to read any further unless you want to, I'll tell you now it worked like a charm. I put the shell into a bed of fire clay and asbestos packed pretty tight and melted some brass and flux into it so it was well coated all around and at the same time kept about ½ inch or so on the bottom in a perfectly fluid condition. Also I heated the copper very hot and tinned it very slightly, keeping the brass so that it was almost ready to run off. Then I plunged the copper into the shell keeping the flame of my torch on the copper so I wouldn't lose any heat and forced down on top of the copper. All of the extra brass squeezed out on top.

We cut this one open after it had cooled and found it was almost perfect. The section looked just like the sectional drawing excepting in a few spots that hadn't been hot enough.

The fellow was well pleased and took my advice about making a cast iron reinforcing case for the shell so it would retain the heat in the copper and steel when the two were forced together; and, he didn't kick about the price, as it was well worth it he thought.

But what I want to know is this. Would you call this brazing or brass founding as I want to know whether I was a brazer or foundryman in doing this job?

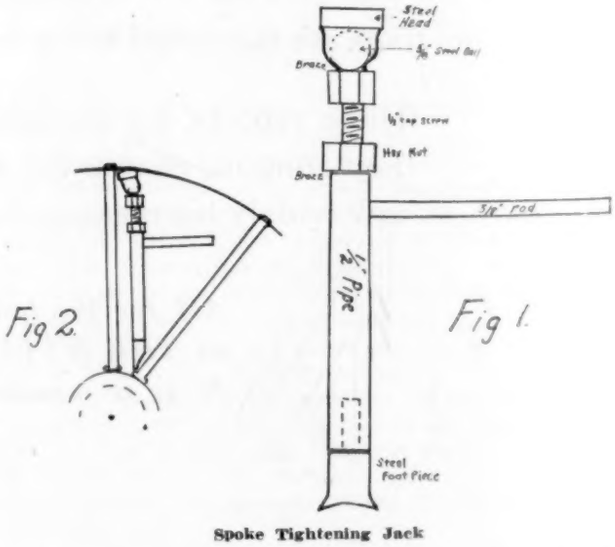
SPOKE TIGHTENING JACK

By Edwin Kilburn

Corn planter wheels and the ground wheels used on other kinds of agricultural machinery often cause trouble from the spokes becoming loose in the hubs, usually the spokes are cast in place, the spokes being provided with two buttons or lugs about ⅜" apart at the hub end, therefore if for any reason the spokes become loose it is a difficult matter to tighten them owing to the inability to reach the inner ends.

We are making use of a jack shown in the accompanying Fig. 1 to tighten the spokes of these wheels, this jack is made of a piece of ½" iron pipe to which is brazed a ½" hexagon nut, for the screw we use a ½" cap screw, on the head of which is brazed a ⅝" steel ball, the top of the cap screw head is formed to receive a small portion of the circumference of the ball, the loose cap of the screw is made of 1" steel shafting, a ⅝" hole being drilled to receive the steel ball and the portion surrounding the ⅝" hole being reduced to about $\frac{1}{32}$" thickness to admit of being drawn tight below the center of the ball to retain the cap on screw. The base of the jack is made of 1" shafting turned for 1½" to fit snugly in the pipe body of jack, the balance of the 1" piece being flattened to a thickness of about $\frac{5}{16}$" and ground to a semi-circular shape to retain it in position on wheel hub when in use.

To use the jack it is placed in the wheel beside the spoke it is desired to tighten, with base against hub and cap against rim, screw is tightened sufficiently to bring inside end of spoke tight against hub, then with the welding torch we build a raised portion on spoke and hub which when cold makes the spoke perfectly tight.



Spoke Tightening Jack

A piece of ⅜" rod welded on the jack body for a handle as shown in Fif. 1 is very convenient in placing the jack, in order to adapt the jack to several sizes of wheels bodies of various lengths may be made by brazing ½" nuts to pieces of pipe of suitable lengths.

Fig. 2 illustrates the jack in use.

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RATHER sweeping in its provisions but necessary if our papers are to hew to the line marked out by Standard No. 1 of our decalogue, which provides that a member of the A B P must "Consider FIRST the interests of the subscriber."

This does not mean that a publisher may not print news about manufacturers and their products, and mention both by name. The makers and vendors of raw and finished products in this field are a part of the industry, a vital part; you are entitled to all the information about them and their goods which will aid you forming intelligent decisions.

It is the business of your business paper to bring you this news, but to present it *wholly* from the standpoint of its NEWS value to you. It is the avowed purpose of every A B P paper to keep its news columns free and clear of the least taint of advertising considerations.

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THE ASSOCIATED BUSINESS PAPERS, INC.

JESSE H. NEAL, *Executive Secretary*

HEADQUARTERS: 220 West 42d STREET NEW YORK CITY

SPECIAL TRUCK FOR WELDING

By Grady Triplett

Whether the job is just around the corner or a hundred miles distant, the D. & P. Engineering Works of Houston, Texas, is prepared to do the work on the scene. A truck, especially equipped for both electric and acetylene welding, is the equipment with which this concern has somewhat erased distance in its work and saved much time for itself and for the industries dependent on welding for repairs.

Prior to the equipping of this truct, the D. & P. concern, whose executives are B. E. Dallerup and H. B. Pollard, had

Special Truck for Welding.

established a reputation for its heavy welding work. Its customers included the oil concerns, with pipe lines and pump stations radiating from Houston. Equipment in need of repairs had to be torn down and shipped to Houston, then repaired, shipped back and installed before it could be put back in use. Many of these jobs were such they could have been done on the scene, had the equipment been convenient.

That prompted the building of the special equipment. A Reo Speed Wagon was adopted for the truck. The bottom of the body was removed and a Lincoln Arc Welder mounted on the channels of the chassis. This is driven by a heavy duty gasoline engine, with generator of 300 volts. On the right side of the truck a reel was installed on which is wound 550 feet of electric lines, giving the welder opportunity to work at long distance from his power unit.

For acetylene welding, tanks are mounted along each running board. The aceteylend tank is mounted on the right side. Adjustable bands are provided for the tank. Then a turnbuckle from the truck body makes it possible to take the weight off the running board. The oxygen tank is mounted on the left side by similar equipment.

Inside the body, between the electric unit and the sides, boxes are placed for tools and supplies. With both welding units ready and tools and supplies on board, the truck provides means of welding comparable to those of the shop. In fact, the electric welder is used at the shop, when not on some job. The truck is driven to the rear of the shop where the lines can be brought inside, the engine started and welding done.

While this truck enabled the concern to take care of work on the scene at a saving of time to itself and money to its customers, it also advertised itself and helped to build a larger business over the Houston territory.

One example will illustrate this. A customer in Navasota, Texas, 70 miles from Houston, called and reported a boiler in need of welding repair. He was told to keep it in his plant. Within three hours, the truck unit was at the scene and the work was completed in two hours. Otherwise two days would have been required for getting the boiler back at work.

By the time this work was done, other industries at Navasota had heard of the presence of the welding unit. They came around to ask about having repairs made to equipment. The result was the truck remained there for two days, being busy on several jobs. All of them made the trip profitable.

An established business has been developing over the Houston territory. The truck covers a distance of 100 miles going day or night to give service to customers of the concern. The repairing of leaking flues in upright boilers has become a sort of specialty by the D. & P. Engineering Works. The reputation for doing this work on the scene brings most of it to this plant.

GAS PRODUCTS ASSOCIATION CONVENES AT ATLANTIC CITY

The tenth annual Convention of the Gas Products Association was held at the Ambassador Hotel, Atlantic City, N. J. on June 10th, 11th, and 12th.

The convention was attended by some eighty members of the association and the wives of several of the members.

A steady increase in the size of the association was revealed in the report of the membership committee, and a greater enthusiasm and "esprit de corps" than ever before were everywhere in evidence.

M. L. Goodrich, President of the Association, characterized this condition in his address to the convention. Outlining the growth and strengthening of the organization, he said in conclusion.

"The organization is recognized as a progressive, wide-awake association that accomplishes results, that renders a genuine service to its members and the industry and those who have contributed most to the upbuilding of the association are, of course, proudest of their product."

During the course of regular business of the convention much new and profitable light was thrown on the various angles of welding and gases in the discussions and addresses on these subjects. Several interesting papers were read before the convention on a variety of topics in the field of gas welding which will be published in full in future issues of *The Welding Engineer*.

Coinciding with the convention of The Gas Products Association was the exhibit of The American Railway Association, which convened at Atlantic City from June 11th, to June 18th. Several manufacturers of welding equipment and gas products were among the exhibitors at this convention.

News of the Welding Trade

The United States Alloy Steel Corporation, Canton, Ohio, has moved its Chicago office to 1440 Strauss Bldg. The district sales manager is Mr. L. K. Townsend.

George E. Casavan has just opened a welding and radiator business. This new shop is known as the National Welding and Radiator Co. and it is located at 318 Shrewsbury Street, Worcester, Mass.

The Autogenous Company is the new name of the former Autogenous Welding & Machine Company, 1217 Maryland Avenue, Baltimore, Md.

The Uhlir Welding Company, 109 West Lawrence Avenue, Beloit, Wis., is remodeling a building at 622-624 Cross Street. The remodeling of this building will double the floor space and will necessitate the purchase of some additional machinery, weld-

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Frank C. Anderson, of the International Oxygen Company, Newark, N. J., who has been on business out west, has now returned to New York and is calling on his old friends as before.

Gibb Instrument company, of Bay City, Michigan, manufacturers of electric arc, spot, seam and automatic welding machines, announce that after July 1st the Chicago office will be in charge of W. F. Hebard & Company, 551 W. Van Buren St. Mr. Thos. Barnes, an officer of the Hebard Company, who will head the

welding department, is an electrical engineer of wide experience. He will be assisted by Chas. Watson. Mr. Watson has had many years of service with the Gibb Instrument Company, both in Japan and the United States, and has been associated with the Chicago office for the past two years.

Mr. Hurd, the retiring representative, has represented the Gibb Instrument Company for the past five years. He will look after the interests of the Gibb Instrument Company in New England after August 1st.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address

Position Wanted—Young man 24 years of age with three years experience in the welding field, the last year of which was on gas pipe work, desires new connection. Can furnish best of references and report on short notice. Address 29, care of The Welding Engineer.

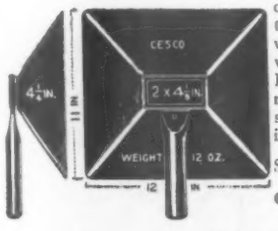
FOR SALE

Gibb Instrument Company, Arc Welder. Serial No. 534. K. V. A. Volts 220. Cycle 60. Secondary. Amps. 300. K. W. 7 5.

For Sale—2-1000 cu. ft. capacity gas holders. Dimensions: Tanks are 17 ft. 7 in. diameter x 6 ft. 1½ in. deep—made of 3-16 in. plate; bottom curb is 2½x2½x⅜ in. angle; top curb is 4x3x⅜ in. angle. Holders are 15 ft. 1½ in. in diameter, 5 ft. 9 in. deep. The shell and crown are made from No. 12 B. W. G. Steel. Bottom and top curbs are 3x3½x⅜ in. angles. The columns of the guide frames consist of four 4 in. I'S, laterals are four 4x4x⅜ in. angle. Vertical shell stiffeners are 3x2½x ⅜ in. angles. Overall height is 13 ft. approximate. Location of the inlet and outlet pipes optional. Address 28 Care THE WELDING ENGINEER.

For Sale—Standard Fuel gas oven furnace, 72"x42", door both ends. Maxim Premix blower system. $400 f. o. b. Detroit, Michigan. Milburn Acetylene Generator, 200 pound, one year's use, $350.00 f. o. b. Detroit, Michigan. Address Slaymaker Electric Welding Company, 686 West Grand Blvd., Detroit, Michigan.

CESCO HAND SHIELD



Style No. 10—Made of Black Vulcanized fibre formed as cut shows to eliminate all light rays. Fitted with our **Essentialite Welding Glass,** which is scientifically correct. Lenses are easily changed by the new device. The jobbers that have seen **Cesco Hand Shield** pronounce it the best made.

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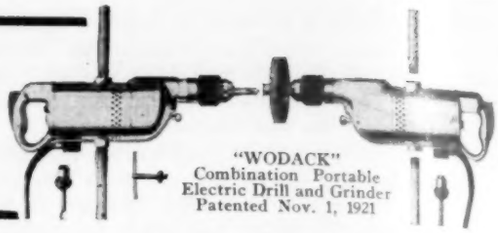

"WODACK" Combination Portable Electric Drill and Grinder Patented Nov. 1, 1921

CURRENT WELDING LITERATURE

MULTIPLE ARC WELDING PLANTS—Discussion of conditions which must be fulfilled by any welding plant designed to supply current to more than one operator. Details of method evolved by the Societe Alsacienne De Constructions Mecaniques Belfort, and system devised by the Premier Electric Welding Co. Ltd. of Manchester. Electrode manufacturers' ideas as to the correct amount of energy for given size electrodes cause confusion. Thickly coated electrodes have a higher arc voltage than thinly coated electrodes, but the current required does not vary quite in the same proportion as the rise in the arc voltage. Hot wire instruments can be made to give average readings on welding circuit but require constant adjustment to keep the zero point the same. Hot suitable instruments .or placing on welding switchboards. In carbon arc welding the electric phenomena met are identical with those in iron arc welding. The energy is greater and a long arc is used with thick heavy work.—Acetylene & Welding Journal, London, June.

OXYGEN REGULATOR SEAT MATERIALS—Investigation under supervision by Mr. J. K. Mabbs, Research Engineer, has shown the practicability of all seat materials for oxygen seat regulators and displayed them under conditions which may occur occasionally in service. The two most common causes for ignition of the seat are: (1) heat generated by sudden compression of oxygen or air in high pressure inlet tube of regulator, (2) small separated or protuding fibers of material on service of seat exposed to high pressure gas. Discussion of materials, their qualifications for elimination of fire and explosion hazard and service. Metal case in compounds and hard rubber discussed.—Acetylene & Welding Journal, London, June.

GAS WELDING ALUMINUM, by S. W. Miller—Usually aluminum alloy is about 93% aluminum and 7% copper. Flux for aluminum welding not always desirable due to time. occupied in cleaning the break and impossibility of avoiding some ferocity in the welding if break is not V'd. Cast aluminum welded by thoroughly puddling while welding without any preparations except wiping off dirt and grease. Procedure in welding. Metal must be melted until bottom of crack is reached using pudding rod constantly. Metal should sink below crack forming beads which may be removed afterward. Characteristics of flame. Why acetylene should be used. Aluminum casting should be preheated to about 500 degrees F. to take care of strains. Asbestos paper keeps temperature uniform. After welding reheat and allow to cool in fire or in asbestos paper wrapping. Manipulation of welding rod and torch. Welding sheet aluminum. Square, clean and flux edges of joints. Very light gauge sheets are butted. Thin sheets are lapped or hooked. General requirements in welding aluminum. Still required by the welder not much different from that required when welding other metals.—Acetylene Journal, July.

STEEL CASTINGS—The Traylor, Wharton Iron and Steel Company, High Bridge, N. J., have recently published a booklet entitled "Putting the Right Steel on the Job." This describes the various products manufactured by this company's three plants. It is very interestingly illustrated.

POWER SUPPLY FOR ELECTRIC WELDING OPERATIONS—By J. H. Paterson.—This is a paper read before the Institution of Welding Engineers in an attempt to deal with the question of power supply in such a manner that it will be understood by those who have not an extensive knowledge of electrical engineering. The supply for iron electrodes and carbon electrodes is considered at length. The discussion is given to flat compound wound generators with a supply pressure of from 50 to 100 volts, compound wound generators in which the series winding is opposed to the main field of the generator and level compounded generators. —Acetylene and Welding Journal, June, 1924, London.

IRON MAKING AND COLD STORAGE PLANTS IN SOUTH AMERICA—This subject is covered in "Trade Information Bulletin" No. 209 which is published by the Bureau of Foreign and Domestic Commerce, Washington, D. C. Details of all plants of this kind in South America are given.

THE USE OF OXYGEN AND GAS MAKING—This has been the subject of several recommendations recently made in the technical press. A commercial attempt in this field is about to begin at Worcester, Mass.—Mechanical and Metallurgical Engineering, May 26, 1924.

THE USE OF CHLORINE IN STERILIZING MILK BOTTLES—Chlorine as a sterilizing agent has been favorably reported upon in the case of milk bottles.—Minnesota State Health Report, May 2, 1924.

REGULATIONS FOR ACETYLENE AND REFRIGERATING SYSTEMS—At the annual meeting of the N. F. T. A., an amendment which led to the "Regulations for the Installation and operation of refrigerating equipment," and proposed "Regulations for the installation and operation of compressed gas system other than acetylene," for houselighting and cooking, was recommended. The association was represented by Mr. H. S. Smith at this meeting.

USE OF ETHYLENE IN COLORING OF CITROUS FRUITS—A method of transforming greenish appearing fruit to a more desirable color is described. Ethylene is provided at the rate of not more than one cubic foot in five thousand cubic feet of space. The new method is said to have decided advantages over the older methods.—Industrial and Engineering Chemistry—16,339-40 (1924).

OXYGEN SAFETY BULLETIN—With this news bulletin there is being forwarded to all Oxygen manufacturers a copy of National Safety Council Safety Bulletin No. 1408, warning against the dangers of the mixture of oils and Oxygen.

THE FUSION WELDING OF ALUMINUM, by C. F. Nagle, Jr.—Principles and theories involved in welding aluminum. Physical laws and fundamental principles show that fusion welding of aluminum is a technical process governed by simple, definite, understood natural laws. Confusion of expansion. Heat conductivity and expansion. Specific heat of aluminum is twice that of copper and half again that of iron. Solidification of aluminum is important phenomena when dealing with its hot shortness. Hot shortness means its lack of strength just at the end of solidification. It is result of expansion and contraction. Characteristics of satisfactory flux for welding aluminum. Must melt below melting point of aluminum. When molten the flux must have the ability to dissolve all of the aluminum oxide quickly. Must be stable under temperatures employed. Must not deteriorate with time. Specific gravity must be less than that of molten aluminum—Acetylene Journal, July.

A HAND BOOK FOR OXY-ACETYLENE WELDERS—"A hand book for oxy-acetylene welders" by Leonard M. Fox, M. I. Mechanical Engineer, Etc., is a 96-page reference and instruction book for oxy-acetylene welding operators. It sets out data and information in non-technical language. Mr. Fox has been associated with the acetylene and welding industries for many years and was the past president of the British Acetylene and Welding Association and also the founder and member of the Council of the New Institution of Welding Engineers. He is, at present, associated with the Allen-Liversidge Co., Ltd., Victoria Station House, Westminster, W. 1, England. This book discusses autogenous welding—the high pressure system—the low pressure system—their applications —properties and metals—how to weld—welding of various metals—metal cutting—flame color chart—high pressure-welding blow pipe and numerous other subjects. It contains many illustrations which pertain to the text. This book is attractively bound in a red cloth cover.

ARC WELDING HAND BOOK—"The Arc Welding Hand Book" by C. J. Holslag, Chief Engineer, Electric Arc Cutting & Welding Co., has just been published by the McGraw-Hill Book Co., New York City. This book is attractively bound in red imitation leather and is comprised of 250 pages and numerous illustrations. It sells for $2.00. It is intended to serve as a simple and practical instruction in arc welding, and an attempt has been made to describe the methods, step by step, so that the beginner may understand both the equipment and the process. To the engineer, draftsman and designer it should serve as a guide in the use of arc welding. The contents consist of 25 chapters which discuss all phases of arc welding.

JOURNAL OF THE AMERICAN WELDING SOCIETY—June, 1924, issue consists of articles covering the Society and related activities of the American Welding Society and gives the following papers: Electric Welding of Large Storage Tanks by Harold C. Price, this paper covers the erection of tanks, tests to which they are subjected, data kept covering the work, machinery and accessories used, advantages of electric welded tanks and future applications of welding; Shop Practice on the Santa Fe by H. A. Patterson; Standardization of Practice in Demolition Work by T. C. Fetherson; Oxy-Acetylene Welding on non-Ferrous Metals by Alfred S. Kinsey, which takes up the metal groups covering copper, brass, alloys of brass, aluminum, aluminum alloy, monel metal, nickel and lead in regard to welding.

INDUSTRIAL HEAD AND EYE PROTECTION—The American Optical Company, Wellsworth Safety Division, has recently issued "Industrial Head and Eye Protection," a well-edited and attractively illustrated house organ, listing the company's models of protective appliances. These range from spectacles and goggles to masks, helmets, and shields.

The book contains some forty or fifty illustrations in addition to a comprehensive discourse on industrial hazards to vision.

One of the features of "Industrial Head and Eye Protection" is a colored chart showing the extent to which the danger from ultra-violet and infra-red rays of gaseous and metallic glare is reduced through Wellsworth Protective Lenses. The American Optical Company is located at 70 West 40th Street, New York City.

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A True High Manganese and High Carbon Product in Rolled Rods and Drawn Wire Presents Highest Abrasive Resistance and Maximum Wearing Qualities

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Style P. A thoroughly practical and comfortable protection for the welder. Note that when preheating or making the work ready the door indicated by the arrow, at the left, opens up, and back of this door is a protection glass. Thus inspection of work is made convenient and free from the danger of filling the operator's eyes with sand.

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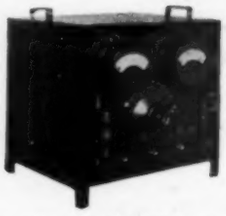

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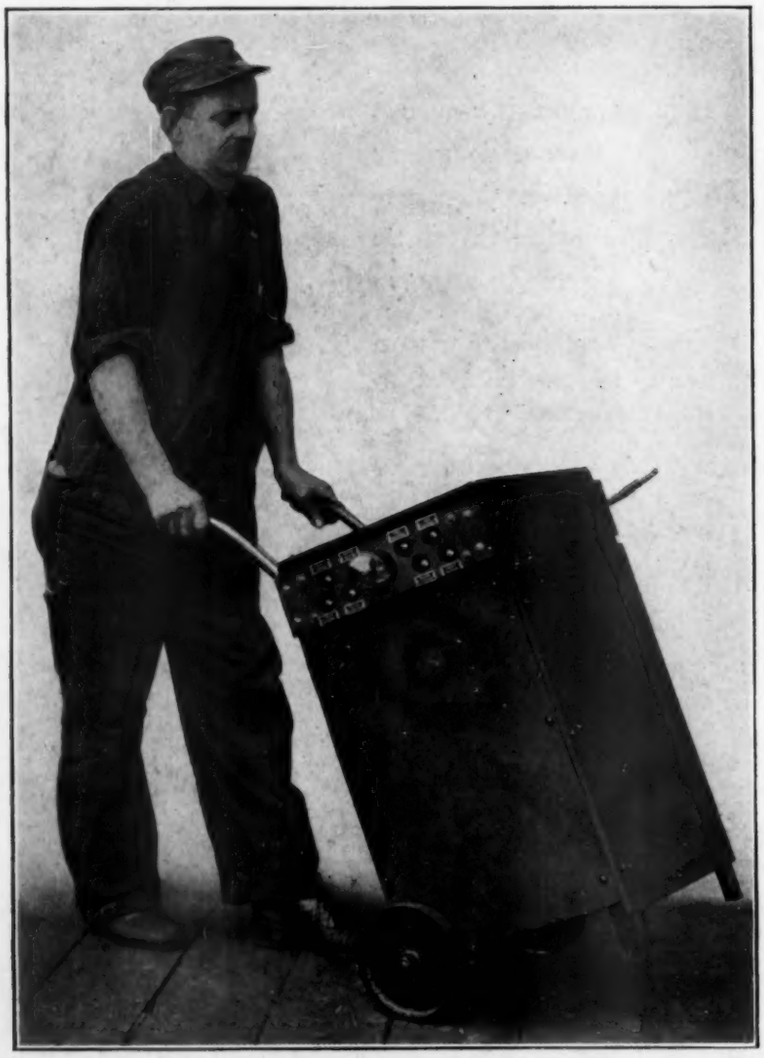

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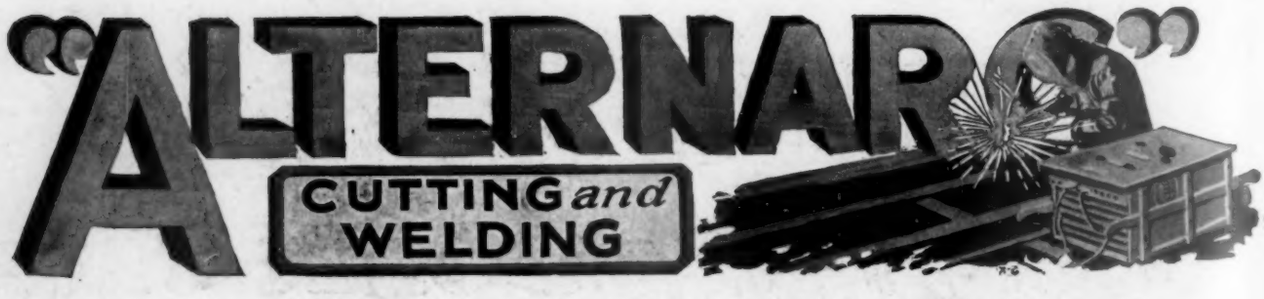
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